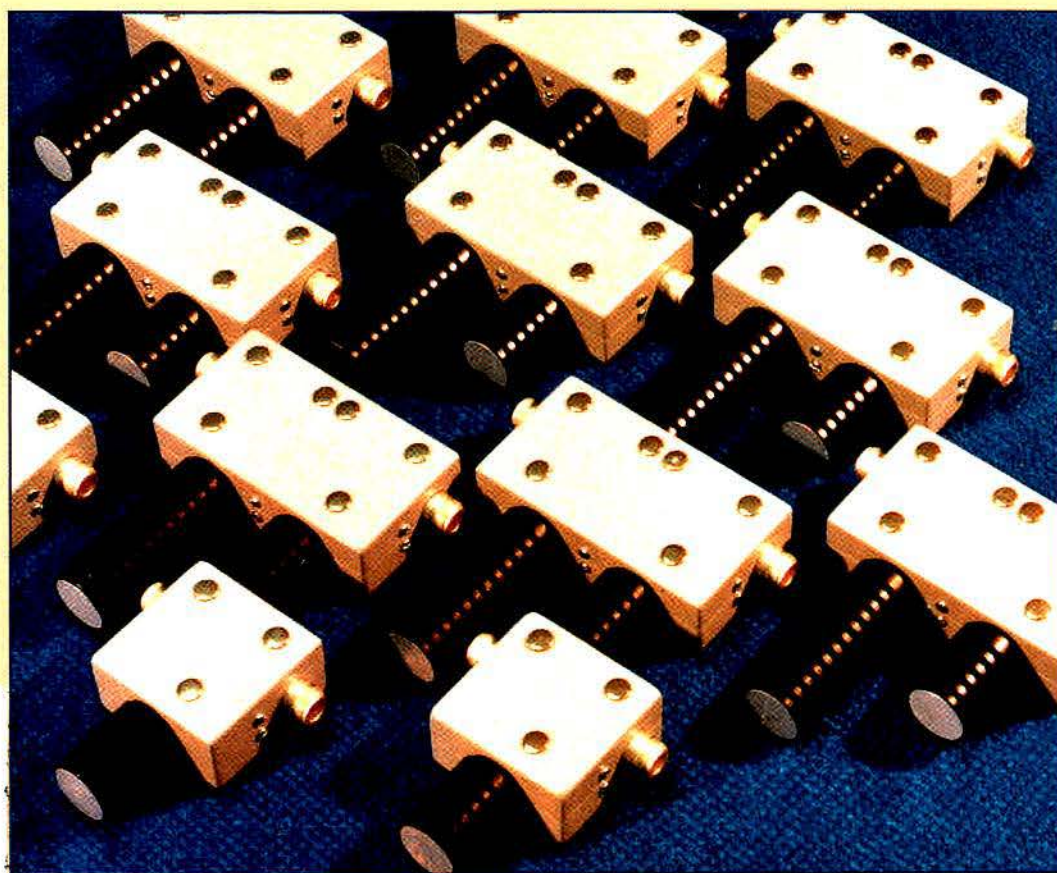


March 1992/\$3.00

Mobile Radio Technology

The journal of mobile communications technology



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Testing and tuning isolators, p. 10

**Nationwide SMR network
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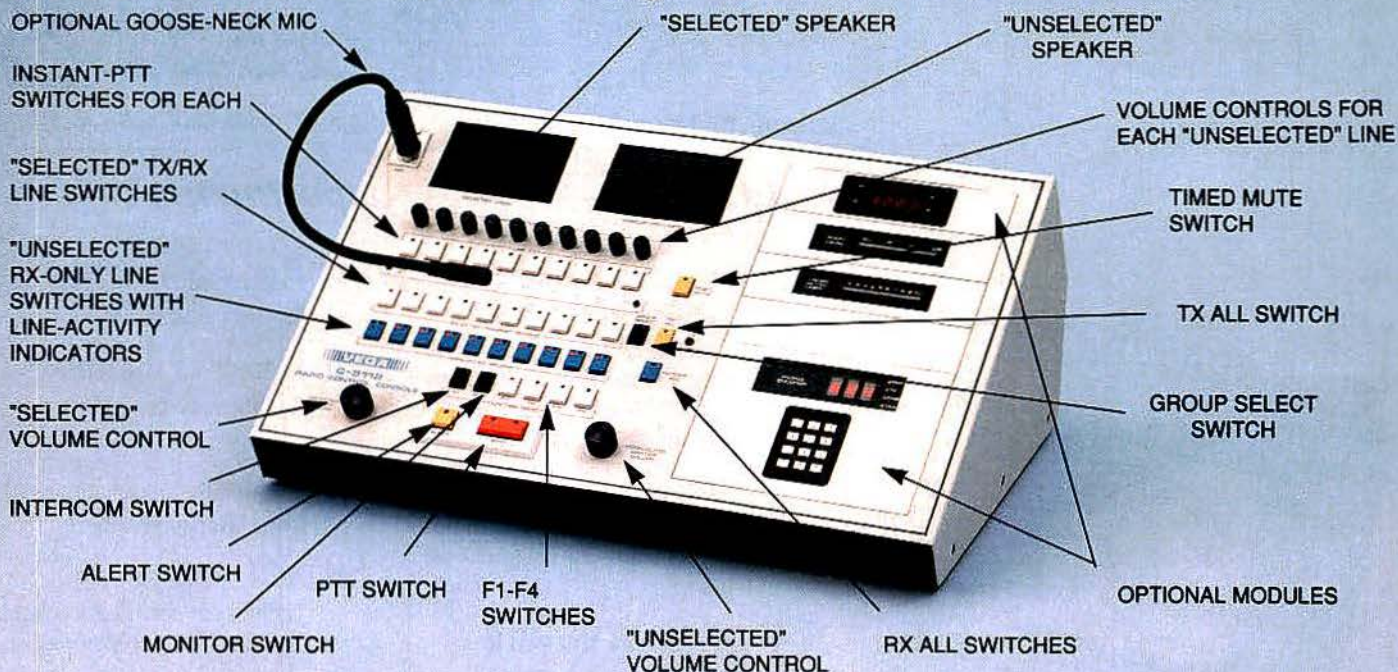
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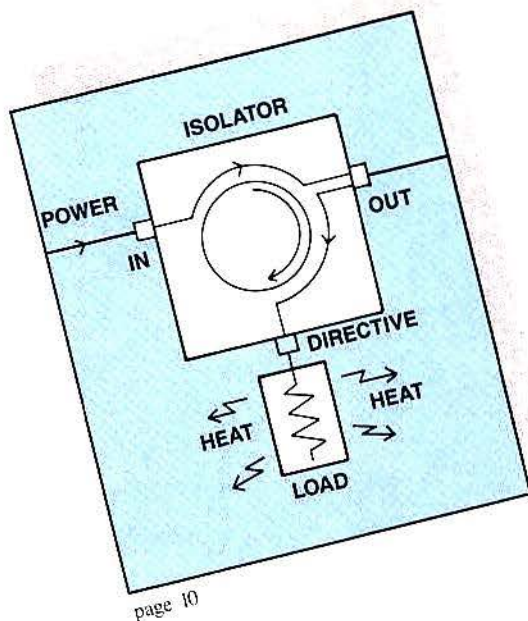
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departments



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Joe Peterzak

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Dick Coe

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Manny Gutsche

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46 Getting into SCADA, staying out of trouble

Larry R. Antonuk

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On the cover: Ferrite isolators. Photo courtesy of Europa Marketing and EMR, Phoenix. See Joe Peterzak's article on page 10.

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Finder's preference may not free many channels



Some potential FCC licensees want access to licensed but unused or underused exclusive-use radio communications channels. Among them are individuals, companies and local governments eligible for licenses in the Business, Industrial/Land Transportation, Public Safety and Specialized Mobile Radio Services.

Certain FCC licensing procedures grant exclusive-use radio channels, meaning only one license-holder can use the frequencies in a given area.

Government rules are violated when the licensee does not build and operate radio facilities the way the license authorizes. Examples include not constructing facilities by the deadline and not operating mobile units. Discontinuing operations for one year or more automatically cancels the license.

An exclusive-use license grants a title to a radio frequency and limits interference, two characteristics that have value. In contrast, licenses for shared frequencies have little or no value because anyone else can apply for a license to use the same frequency in the same area, perhaps subject to frequency coordination.

Whistleblower

Equipment dealers and consultants who have experience in a local area know the violators. Previously, there was little reason to give the FCC evidence of violations. A frequency recovered for rule violations was not necessarily reassigned to the informant. The successful applicant might be the whist-

leblower's competitor. Thus, unseating an existing exclusive-use license-holder might do an informant more harm than good.

The finder's preference program is supposed to change all that. Now, someone who submits acceptable evidence can be granted a preference when applications are processed for the violator's frequency.

Public safety agencies

The rules exclude frequencies in the 800MHz Public Safety pool occupied by public safety entities. They exclude frequencies in the public safety 821MHz-to-824MHz and 865-to-869MHz band unless the regional planning committee for the location concurs in writing that the finder's preference is not inconsistent with the regional plan. ("No way in hell" is the likely response, should anyone ask.)

On the other hand, public safety applicants may unseat Business and Industrial/Land Transportation licensees via intercategory sharing and replace them with public safety radio facilities.

What is this really?

The finder's preference isn't clear to everyone. "If a finder provides the information leading to the recovery of a channel through the finder's preference program, then that person or entity will be awarded a dispositive preference in acquiring a license on that channel," according to the FCC.

The Special Industrial Radio Service Association (SIRSA) believes the only preference the finder obtains is to operate a radio facility at the existing authorized location. "Relocation of the channel(s) or modification of the operating parameters, such as effective radiated power, is not part of the preference," a SIRSA document reads.

"A frequency coordinator may refuse to coordinate a finder's preference application if it specifies modifications that adversely affect existing systems—even if such systems were coordinated and granted after the preference request was filed, but prior to the preference grant and the filing of the preference application," according to SIRSA.

Clear? Apparently, not clear enough to assure everyone that the finder's

preference program is ready to run smoothly.

Putting it to work

What would seem to be the most clear-cut finder's preference opportunity, identifying a license that was canceled automatically for discontinued operations, may be the most rare and the most difficult to prove.

The next opportunity, identifying a failure to place mobile units in operation, likewise may be difficult to prove, and fairly rare.

What once was more common, failure to construct, is more rare today than it was a few years ago. Proving it may be easier than the first two, though. The authorized repeater site can be photographed, and the frequency can be monitored to gather evidence.

The violation that galls hungry potential licensees the most and that sometimes is the easiest to prove, failure to load a system with the required number of mobiles, is not included in the finder's preference program. The FCC considered including loading violations and decided against it.

Loading violations should be included, at least on non-specialized mobile radio (SMR) systems.

Exactly what violations are included in the program may not make much difference if the FCC finds the evidence that applicants may submit is not credible. Evidence submitted by third parties does not always carry much weight with the commission, regardless of its comprehensiveness.

If anyone actually obtains a channel under the finder's preference program, we'd like to hear about it. The program is going to be difficult to use.

Perspective

From the perspective that rules have been enacted to recover channels from violators and to reassign them to whistleblowers, the finder's preference program is a done deal. From the perspective of those who might actually try to obtain frequencies by that method, the finder's preference program may be more of a work in progress.

—Don Bishop

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Volume 2, No. 1

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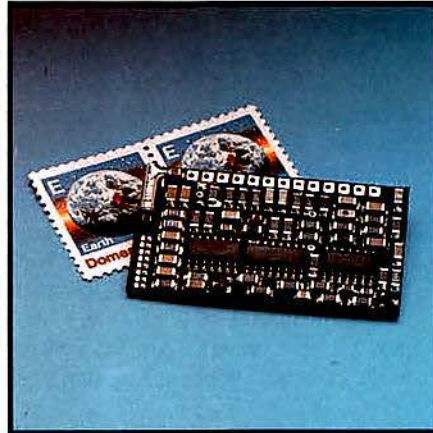
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Portable radios:

Over the past decade, there has been a revolution in hand-held radio technology, with unit size and price shrinking at an amazing rate. As the numbers and types of portable radio end-users have expanded dramatically, I cannot help but think that many traditional end-users and long-established dealers now are being left out in the cold.

The problem is that some end-users subject their hand-helds to rugged use, and many new portables cannot stand the abuse that the old "bricks" could take. The portable radio business has become a three-ring circus, with so many manufacturers offering so many models through so many sellers, resellers and dealers that some long-standing end-users are having a really tough time sorting out the best value in portable radios for their field applications.

For these people, there currently is a need to sort through all the marketing

sizzle and glitz, get off the desert cruise ship and go back to fundamental values.

In my experience, the best example of perceiving user values came from the oil patch. In the early '80s, a drilling manager was having a tough time staying in touch with a drilling rig in a remote part of the Rocky Mountains. The rig had a radiotelephone tied into an overloaded terminal. The supplier balked at providing better service because it would increase monthly costs from \$135 to \$1,500.

The drilling manager's reaction was: "That rig is costing \$20,000 per day, and I cannot communicate with the site supervisor. The \$50 per day our supplier is concerned about is small change. Get that interconnect in place and working...now!"

With hand-held radios, price may not be as important as reliable performance. The field failure of a \$200 hand-held may tie up a crew for a cost of \$2,000 to the end-user. When selling hand-held

radios, a clear understanding of the end-user's applications and costs help you to choose the right quality of product for the job.

Reliability has become a big concern. When a client's radio breaks, will repair take an electron-scanning microscope and a micro-midget technician? Will parts be available?

We now are in the age of the "break it and throw it away" portable radio. Some clients do not understand this situation. They always have been able to get their hand-held fixed by their dealer's technicians, and in the backs of their minds, they still think that your super-technician will be able to fix their throw-away radios.

If they pay \$300 for a throw-away radio, they may have a heart attack when presented with a \$100 repair bill or the news that the radio they have owned for only two months cannot be fixed and is not covered by warranty because it was dropped into a mud puddle.

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The journal of mobile communications technology

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**Make The
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Letters to the editor

Part of the problem with our industry's three-ring circus is the Fly By Night Radio and Bagel Emporium that promises your customer the world, eats up your market share and then moves on to the new Satellite FAX Flat Tire Reporting Technology business, leaving you with the mess. The best way to combat this problem is to establish a close, long-term relationship with your

client.

Take the time to understand *all* of your client's needs and priorities. Present solid reasons for recommending equipment and give reasons why you do not recommend specific alternatives.

Remember, among your assets are technology, radio expertise, the ability to match user needs with technology better than anyone else, and the ability

to support the client over the long term. Price is not the sole factor, as long as the client is knowledgeable. That knowledge comes from you, the dealer.

Another big problem these days is that it is easy to advertise a new product as rugged, but tougher to match the claims with reliable field performance. At the same time, the rate of new models from manufacturers has accelerated dramatically. Some hand-held radio users are real animals when it comes to shredding advertising claims. They make military specifications meaningless.

Some clients can anticipate purchases far enough ahead to allow you to work with the end-user to try various new models and sort out which performs best in the field.

A good client will work with you to fund such an evaluation because it is better to write off a few radios in an experiment than to get stuck with a whole bunch of radios that fail to meet user needs.

Your service manager may be one of the greatest assets you have for identifying customers with problems and hand-held radio models that are not making it in the field. Use that feedback to keep in touch with your clients and their problems.

If your business is built on sales and service, you may choose not to service mail-order radios from clients who only want service and always buy from the cheapest source. Alternatively, you may consider preferred service rates for clients who buy from you and who want long-term support.

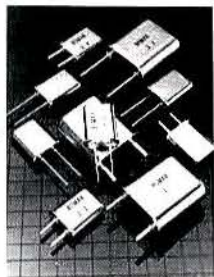
The main reason I wrote this letter is that I sometimes get frustrated with the three-ring circus and think, "if I can't fight them, why not join them?" This letter is an exercise in stating important business fundamentals that our industry needs to stay legitimate.

For you who work hard to build a good reputation with end-users and to build solid long-term businesses, I say keep up the good work, and remember that down in Dallas, JR finally became history.

Rand G. Ellis
Marketing Manager
Radio Systems
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Testing and tuning isolators in the field

Use common shop test equipment to test and tune isolators in the field for reuse in new applications. Isolators can be retuned in the field over a limited frequency range to save time and money.

By Joe Peterzak

Ferrite isolators are commonly used in two-way radio systems to reduce intermodulation interference (intermod). An isolator prevents signals from other nearby systems from entering the transmitter. Blocking these unwanted signals reduces or eliminates intermod that

Peterzak developed and manufactures a swersweep SWR measurement kit. He owns Europa Marketing, Mesa, AZ; 602-345-6666.

otherwise might result.

Sometimes old isolators can be reused in new radio systems. For example, an isolator may become available when a repeater is taken out of service or replaced. To reuse the isolator in another system usually requires retuning it to a new frequency.

Previously, old isolators had to be returned to the factory for retuning because shop technicians lacked the necessary equipment and information. But with the help of a service monitor with a tracking generator and a swersweep

SWR measurement kit, a technician can retune an isolator properly in the field.

Method

The method of properly tuning an isolator in the field is similar to the way it is done at the factory.

Factory technicians tune an isolator while watching a dynamic graph representing standing wave ratio (SWR) vs. frequency displayed by a network analyzer, an expensive laboratory test instrument.

A shop technician tunes by watching

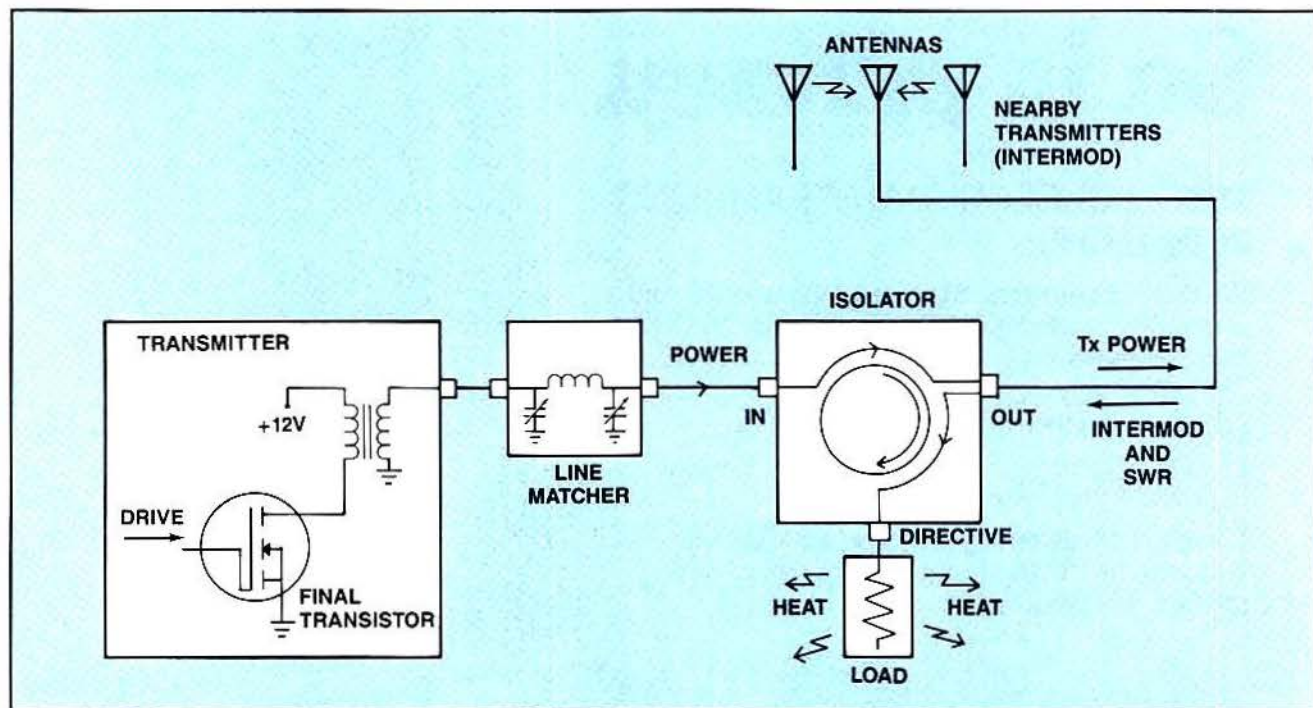


Figure 1. A typical transmitting system with an isolator. The isolator is a 'traffic control' for radio energy. It passes transmitter power to the antenna. But signals entering the antenna from other nearby transmitters and reflected power are diverted to a resistive load that converts the energy to heat.

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Circle (10) on Fast Fact Card

a similar graph on a service monitor's cathode-ray tube (CRT) display. A swer-sweep SWR measurement kit enables the service monitor to produce the display. More information about this test method appears in "Swersweep: A New Method Of Measuring SWR" in the October 1989 issue.

Figure 1 on page 10 is a diagram of a typical transmitting system with an

isolator. The isolator is a "traffic control" for radio energy. It passes transmitter power to the antenna; nevertheless, signals entering the antenna from other nearby transmitters are diverted to a resistive load that converts the energy to heat.

Without an isolator, such unwanted radio energy would enter the transmitter, where it may cause problems. Sig-

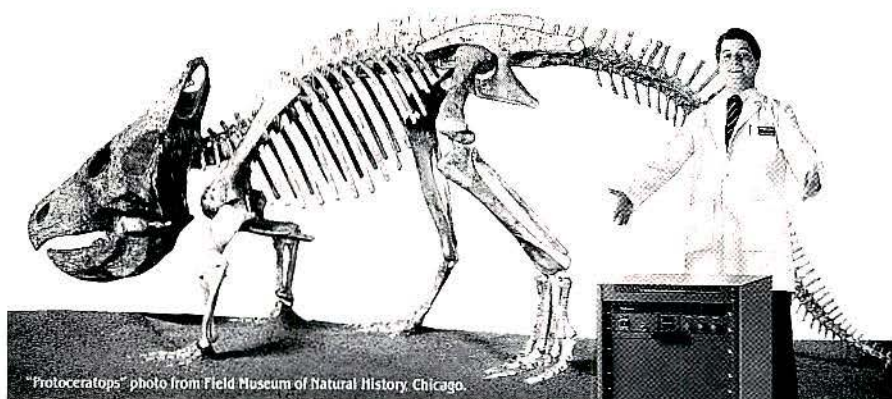
nals from one or more nearby transmitters mix with the transmitter's signal. The result is two or more additional "intermod" signals on unwanted frequencies that exit via the antenna. "Intermod" frequencies may interfere with radio reception at the same site and, if they are strong enough, at other sites many miles away.

An isolator offers a second benefit: Any impedance mismatch caused by an improperly adjusted or damaged antenna reflects transmitter power at the antenna feedpoint. The reflected energy returns to the transmitter, where it may cause excess heat and strain the final amplifier devices. An isolator diverts the reflected power to the resistive load, where it dissipates as heat.

Isolator specifications

The most common type of isolator used for two-way radio systems is called the *narrowband tunable isolator*. It is

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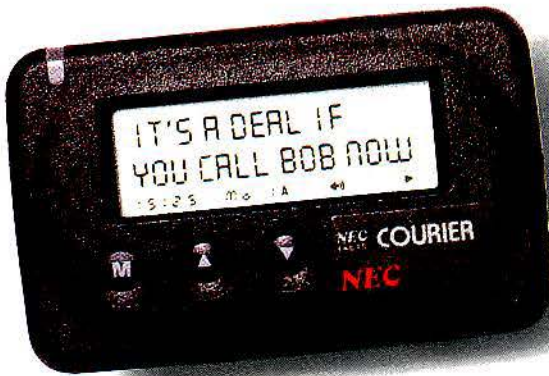
Circle (11) on Fast Fact Card

A tunable isolator usually has caps on its cover to allow access to adjustments...

optimized at the factory at an *exact* operating frequency. A tunable isolator usually has caps on its cover to allow access to adjustments that affect some, but not all, of the operating limits. More about those adjustments later.

Isolator performance has improved dramatically over the years. Modern single-stage isolators provide as much as 40dB of isolation between transmitter and antenna ports with a transmitter power loss of as low as 0.1dB or about 4.5% of the power. Early production models provided only 20dB of isolation and wasted more than 20% of the transmitter power.

Before retuning an isolator, check its original specifications to determine whether it will meet performance requirements in your new application. Keep in mind that the original specifications may be degraded slightly when



Sooner.

to 32 characters on its easy-to-read, illuminated screen. Its 6500-character memory base provides you with push-button access to as many as 40 messages, addresses, memos or reminders.

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Some messages can't wait until you get back to the office. You can imagine the scenario. You're out on the road and your pager goes off. You check the screen and don't recognize the telephone number. Figuring there's no rush, you decide to wait until you get back to the office to find out who called.

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FROM		7/22	3/25	PM
OF		AREA CODE		
		NO. (212) 659-3497		
		EXT.		
PHONE MEMO	MESSAGE			
	It's a deal if you call Bob now!			
	SIGNED			
PHONED	CALL BACK	RETURNED CALL	WANTS TO SEE YOU	WILL CALL AGAIN
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
WAS IN				URGENT
				<input checked="" type="checkbox"/>

Or later.

NEC

Circle (12) on Fast Fact Card

an isolator is retuned significantly from the factory-optimized frequency.

Swersweep method

When retuned with the swersweep method, isolator ports are optimized as nearly as possible to 50Ω impedance at the new operating frequency. This adjustment is all that can be done in the shop. To completely retune an isolator

as it would be done in the factory, adjustment of the strength of the isolator's magnets and other elements would be necessary.

Because equipment in the average shop cannot be used to adjust the magnetic field strengths, the final results of the field adjustment method often are less than optimum. The practical limit of a field adjustment ranges from 5%

to 15% above or below the frequency set at the factory. The limit differs with each brand of isolator and frequency band.

The best way to find how far an isolator will tune from the frequency set at the factory is to forget the math and simply retune it. Measure the result to determine if the isolator's performance on the new frequency meets the new application's requirements. If the result is unsatisfactory, the isolator can be retuned to its original "stock" frequency and used elsewhere.

Never open an isolator's case. Proper isolator operation depends on its internal magnetic field, which cannot be adjusted in the field with typical shop equipment. Removing the covers makes

Never open an isolator's case. Proper isolator operation depends on its internal magnetic field...

the case move, distorting the magnetic field and often degrading the isolator's performance.

Test procedures

Use the following four procedures to test and retune an isolator to a new frequency.

First, test the isolator by following the steps and recording the results without making adjustments. Compare the results with the manufacturer's specifications, if they are available, to reveal any problems.

If the isolator is in good shape, retune it to the new operating frequency. Repeat steps two through four because the adjustments may interact slightly.

Record the results at the new operating frequency and compare them to results obtained at the original frequency. This comparison shows how much the performance has been degraded and whether the retuned isolator will work suitably in your new application.

Swersweep calibration

The swersweep provides a precise



Receive only	Freq. Ranges (MHz)	N.F. (dB)	Gain Comp. (dB)	1 dB (dBm)	Device Type	Price
P30VD, P35VD, P40VD, P45VD	30-35, 35-40, 40-45, 45-50	<1.3	15	0	DGFET	\$ 44.95
P30VDG, P35VDG, P40VDG, P45VDG	30-35, 35-40, 40-45, 45-50	<0.5	26	+12	GaAsFET	\$109.95
P150VD, P160VD, P170VD	150-160, 160-170, 170-180	<1.5	15	0	DGFET	\$ 44.95
P150VDA, P160VDA, P170VDA	150-160, 160-170, 170-180	<1.1	15	0	DGFET	\$ 56.95
P150VDG, P160VDG, P170VDG	150-160, 160-170, 170-180	<0.5	24	+12	GaAsFET	\$109.95
P450VD, P460VD	450-460, 460-470	<1.8	15	-20	Bipolar	\$ 49.95
P450VDA, P460VDA	450-460, 460-470	<1.2	16	-20	Bipolar	\$ 74.95
P450VDG, P460VDG	450-460, 460-470	<0.5	16	+12	GaAsFET	\$109.95
P800VDG, P830VDG, P860VDG	800-830, 830-860, 860-890	<0.6	19	+12	GaAsFET	\$119.95
Inline (rf switched)						
SP30VD, SP35VD, SP40VD, SP45VD	30-35, 35-40, 40-45, 45-50	<1.4	15	0	DGFET	\$ 74.95
SP30VDG, SP35VDG, SP40VDG, SP45VDG	30-35, 35-40, 40-45, 45-50	<0.55	26	+12	GaAsFET	\$139.95
SP150VD, SP160VD, SP170VD	150-160, 160-170, 170-180	<1.6	15	0	DGFET	\$ 74.95
SP150VDA, SP160VDA, SP170VDA	150-160, 160-170, 170-180	<1.2	15	0	DGFET	\$ 86.95
SP150VDG, SP160VDG, SP170VDG	150-160, 160-170, 170-180	<0.55	24	+12	GaAsFET	\$139.95
SP450VD, SP460VD	450-460, 460-470	<1.9	15	-20	Bipolar	\$ 79.95
SP450VDA, SP460VDA	450-460, 460-470	<1.3	16	-20	Bipolar	\$104.95
SP450VDG, SP460VDG	450-460, 460-470	<0.55	16	+12	GaAsFET	\$139.95

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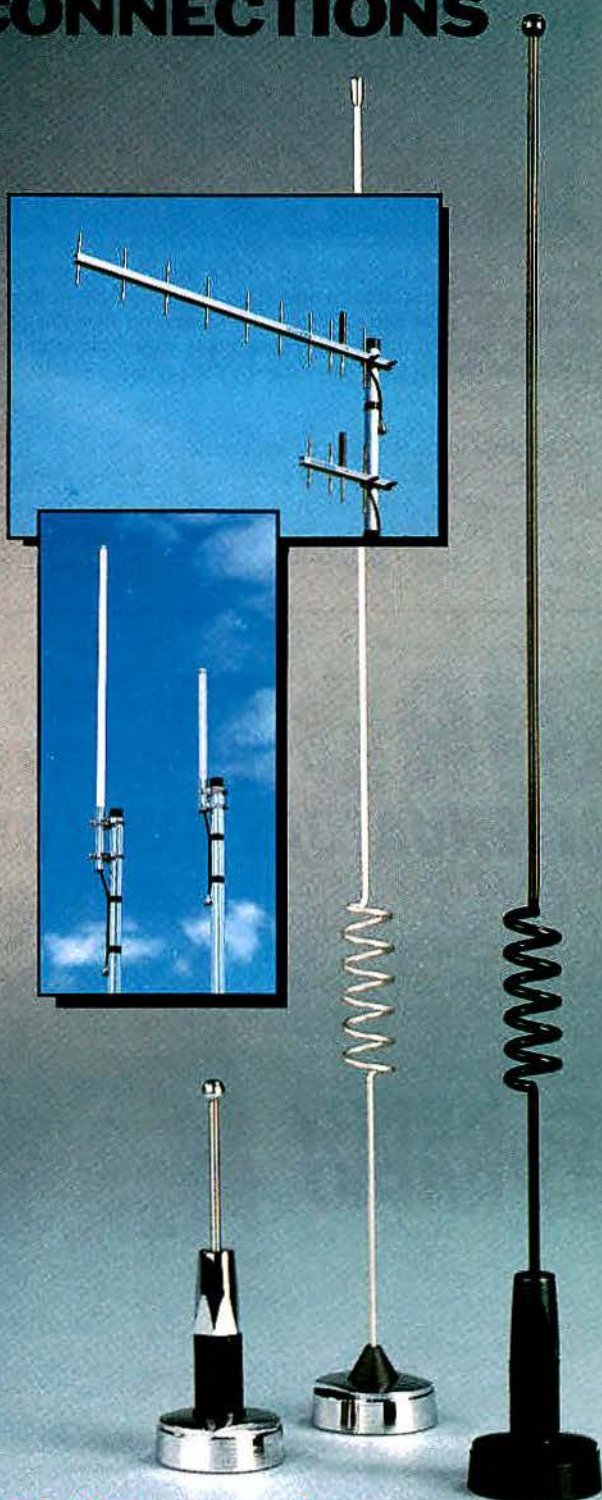
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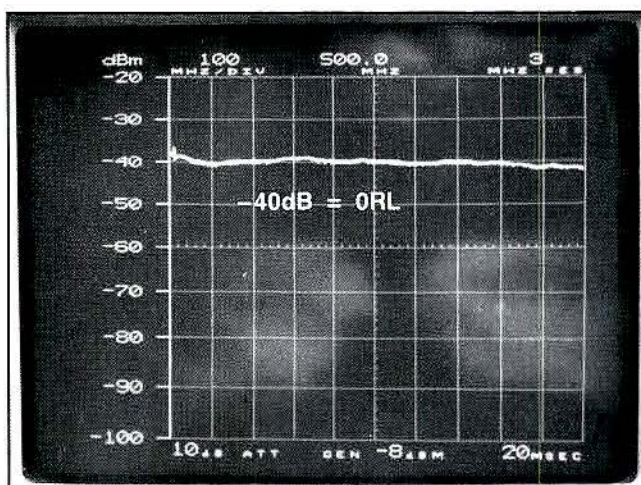


Photo 1. An open test port. Adjust the service monitor's center frequency to the isolator's operating frequency. Open the swersweep's test port and calibrate the screen so that the 0dB return loss (0RL) (infinite SWR response) intersects with one of the upper horizontal graticules—in the picture, -40dB.

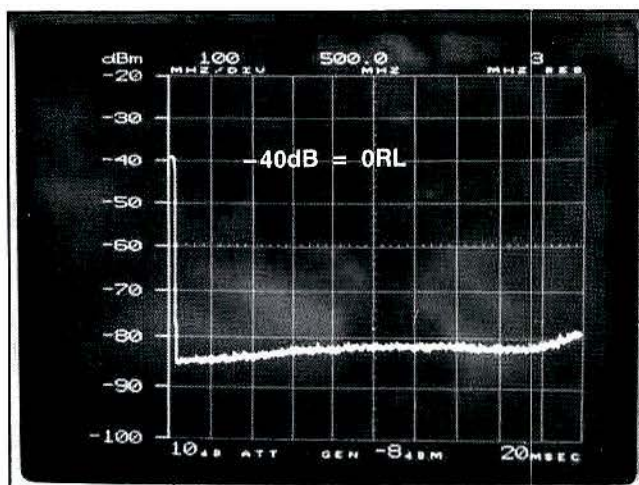


Photo 2. A terminated test port. Test the system by connecting the NIST-traceable reference load onto the test port and verify that the calibration line drops more than 40RL. The screen shows the excellent SWR (1.01:1) provided by the reference load over frequency.

50Ω source impedance to which the device under test is compared in terms of "return loss." Return loss may be converted to SWR. It represents the difference, in decibels, between reflected RF

power to RF power applied across a band of frequencies and displayed as a swept response. The swersweep allows the device under test to be adjusted for the lowest possible reflected power.

"RL" stands for "return loss in decibels"; for example, 30RL means 30dB of return loss or 1.15:1 SWR.

Adjust the service monitor's center frequency to the isolator's operating frequency. Open the swersweep's test port and calibrate the screen so that the 0dB return loss (0RL) (infinite SWR response) intersects with one of the upper horizontal graticules. (See Photo 1 above.)

Test the system by connecting the NIST-traceable* reference load onto the test port and verify that the calibration line drops to more than 40RL. The screen shows the excellent SWR (1.01:1) provided by the reference load over frequency. (See Photo 2 above and Figure 2 on page 18.)

► **Step 1**—Checking the isolator's load.

Remove the isolator's load termination from the directive port and connect it to the swersweep's test port as you observe the swersweep response on the screen. The isolator's load termination should provide 35RL or better. Replace the isolator's load if it cannot deliver 35RL or better at the operating frequency.

► **Step 2**—Output matching.

Set up the test system as shown in

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*NIST stands for the National Institute of Standards and Technology, formerly the National Bureau of Standards (NBS).

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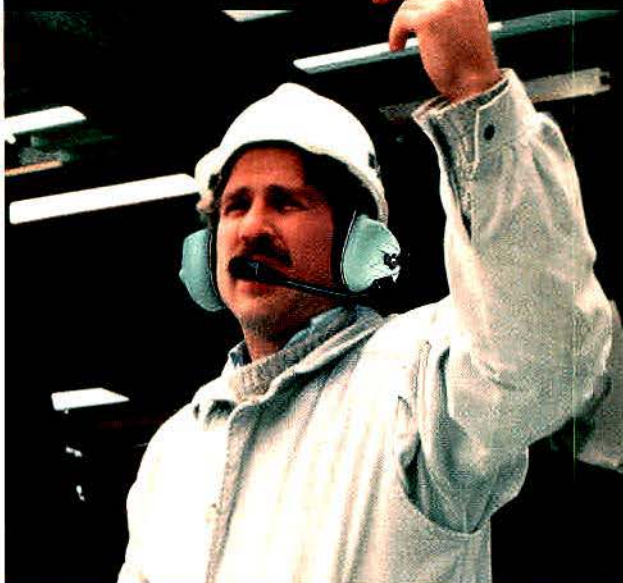
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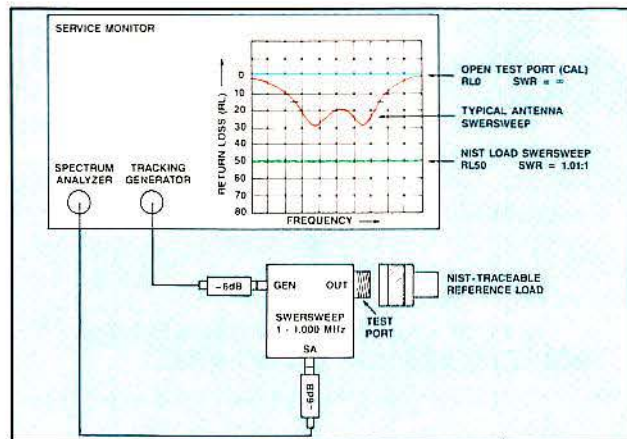


Figure 2. Connect equipment as shown to calibrate the screen and to test the system with an NIST-traceable reference load. Expected traces are shown in colors.

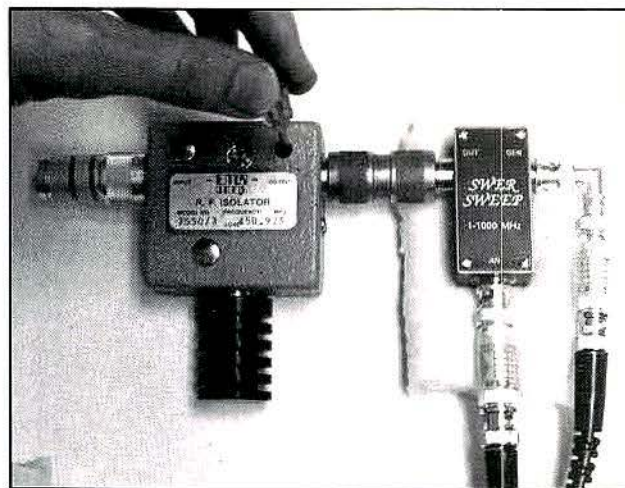


Photo 3. Input and output matching. Set up the test system connecting the swersweep to the 'out' port and the reference load to the 'in' port. Return the isolator's load to the 'directive' port. Adjust tuning capacitors as described in the text.

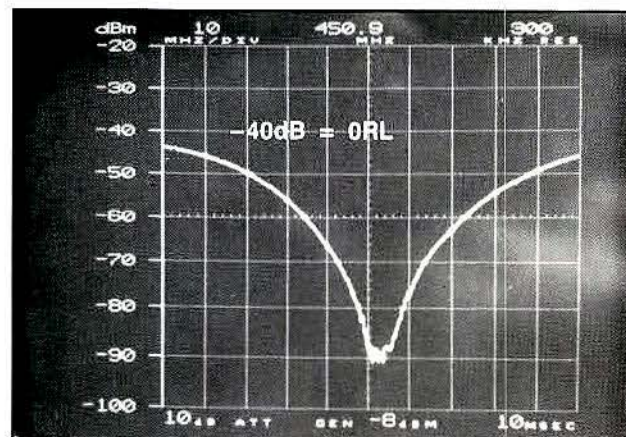
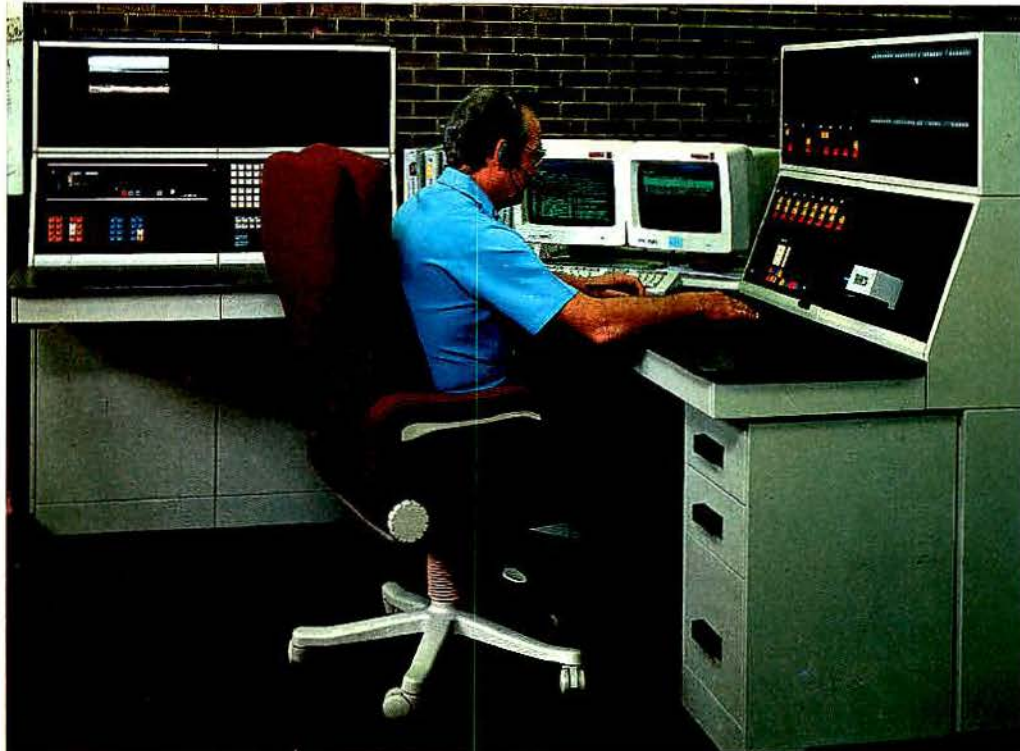


Photo 4. Isolator input and output swersweep. Watch the screen as you adjust the capacitors so that the best RL response occurs at the middle of the screen. This swersweep of the retuned isolator's input and output shows 48RL at the operating frequency (-40dB = 0RL).

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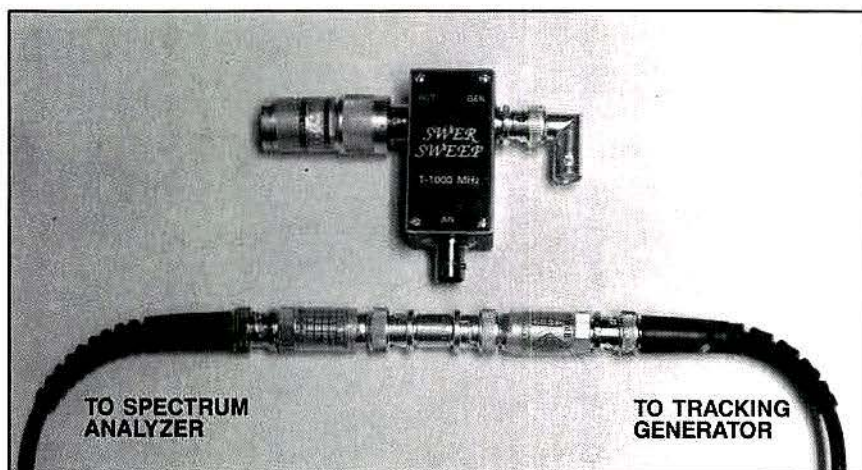


Photo 5. Calibration for isolation. Remove the two attenuators and cables from the swersweep coupler and connect them together with a BNC barrel. Adjust the service monitor's screen so the 0dB insertion loss calibration line intersects with one of the upper graticules as shown in Figure 2.

Photo 3 on page 18 by connecting the signal source through the swersweep to the "out" port. Return the isolator's load to the "directive" port and terminate the isolator's input port with the NIST-traceable load, using an adapter if

necessary. Adjust the output tuning capacitor as you watch the screen so the best RL response occurs at the middle of the screen. The swersweep response should resemble Photo 4 on page 18 and should have a minimum of 30RL at the

operating frequency in the center of the screen.

► **Step 3—Input matching.**

Connect the swersweep's test port to the isolator's "in" port. Connect the NIST-traceable load to the "out" port. Repeat step two, but adjust the *input* tuning capacitor. A swersweep response similar to Photo 4 should be obtained.

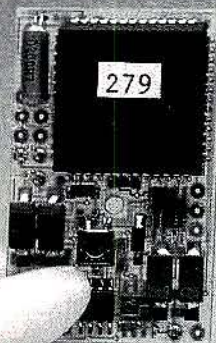
► **Step 4—Measuring isolation and insertion loss.**

Remove the two attenuators and cables from the swersweep coupler and connect them together with a BNC barrel as shown in Figure 5 at the left. Adjust the service monitor's screen so the 0dB insertion loss calibration line intersects with one of the upper graticules as shown in Figure 2.

Once calibrated, set up the test equipment as shown in Photo 6 on page 22 to display the *isolation* as shown in Photo 7 on page 22.

To measure isolation and insertion loss, the tracking generator applies a signal to the isolator from the reverse direction, and the spectrum analyzer

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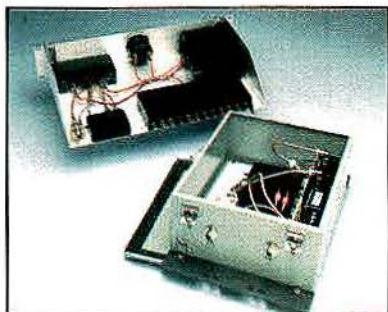


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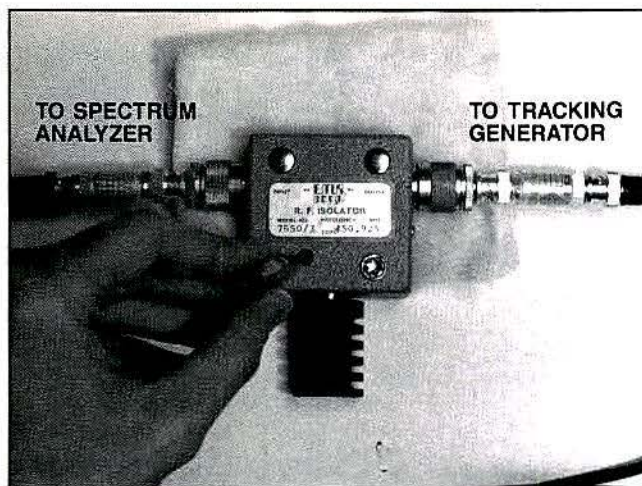


Photo 6. Isolation test. To display isolation, connect the attenuators and adjust the directive tuning capacitor so the isolation notch occurs at the center of the screen.

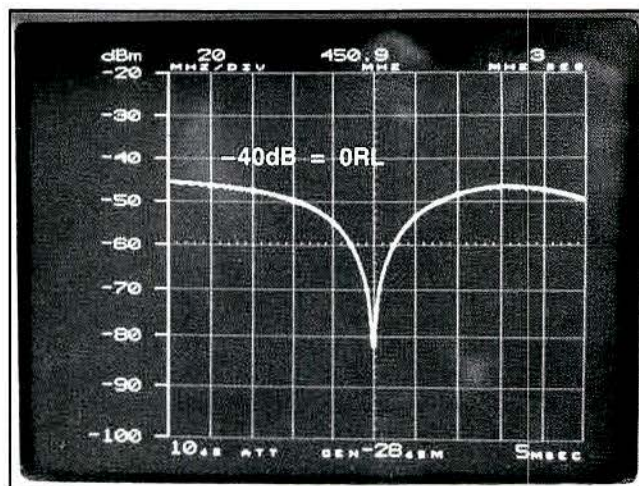


Photo 7. Isolation response. The value displayed at the center of the screen subtracted from the calibration line is the isolator's isolation in decibels at the operating frequency.

displays the result. This procedure simulates unwanted signals coming back from the antenna, as shown in Figure 1. The reading obtained on the screen is the actual isolation value in decibels at the operating frequency.

During this test, slowly unscrew the

load from the directive port while the isolation is displayed on the screen. Notice that the response changes dramatically. This demonstration shows why proper RF connections are necessary for optimum performance of the isolator and transmitting system.

Adjust the directive tuning capacitor so the lowest response occurs at the center of the screen. The value displayed at the center of the screen subtracted from the calibration line is the isolator's isolation in decibels at the operating frequency.

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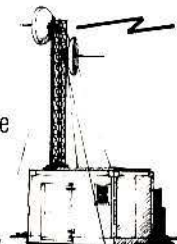
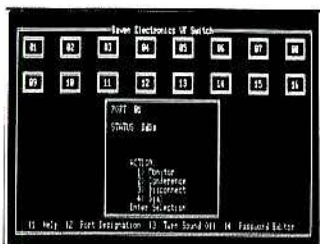
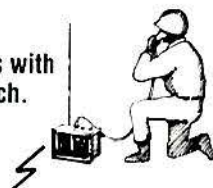
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The swersweep, along with modern radio test equipment, has made it possible to test and tune isolators in the shop. With this simple procedure, time and money can be saved compared with sending an isolator back to the factory for retuning.

Additional reading

1. Lieske, William F., *Intermod Control*, Wiesner Book Company, Englewood, CO, 1984. (Copies are available postpaid for \$12 check or money order only, payable to Wiesner Publishing. Write: Circulation Department, Wiesner Publishing, 7009 S. Potomac St., Englewood, CO 80112. Allow two to four weeks for delivery.)
2. Peterzak, Joe, "Swersweep: A New Method Of Measuring SWR," *Mobile Radio Technology*, October 1989. (Back issues are \$5 postpaid. To order by mail, send a check or money order payable to Intertec Publishing to Dee Manies, Intertec Publishing, P.O. Box 12901, Overland Park, KS 66212. To order by telephone using a credit card, call Dee Manies at 913-541-6628.)

Acknowledgment

Products used for testing and assistance with test procedures were provided by William F. Lieske, president of EMR Corporation, Phoenix; and Hartley Gardner of Electronic Site Solutions, Phoenix.



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Terrestrial network improves fleet efficiency

An earth-based nationwide network links truckload dispatchers and their vehicles with real-time voice and data communications, which improves the coordination of shipping and receiving operations.

By Dick Coe

Some truck load (TL) carriers require not only vehicle location reports, but real-time voice and data communications. Current orbital-satellite-based services lack real-time voice and data communications capability. Meanwhile, a nationwide terrestrial network using 800MHz specialized mobile radio (SMR) technology delivers both vehicle location reporting and real-time voice and data communications.

In the beginning

In the earliest days of commercial

Coe is manager of engineering services, Network Services, Motorola Land Mobile Products Sector, Schaumburg, IL.

ground transportation, drivers used the pay telephone to keep in touch with dispatchers and customers. The pay telephone provided private, real-time voice communication, although communication sometimes was delayed because of a lack of a conveniently located phone or the coins to operate it, or by an out-of-order phone.

► *Community repeater*—Real-time communication with the dispatcher in the vicinity of the terminal improved with the use of shared two-way FM radio.

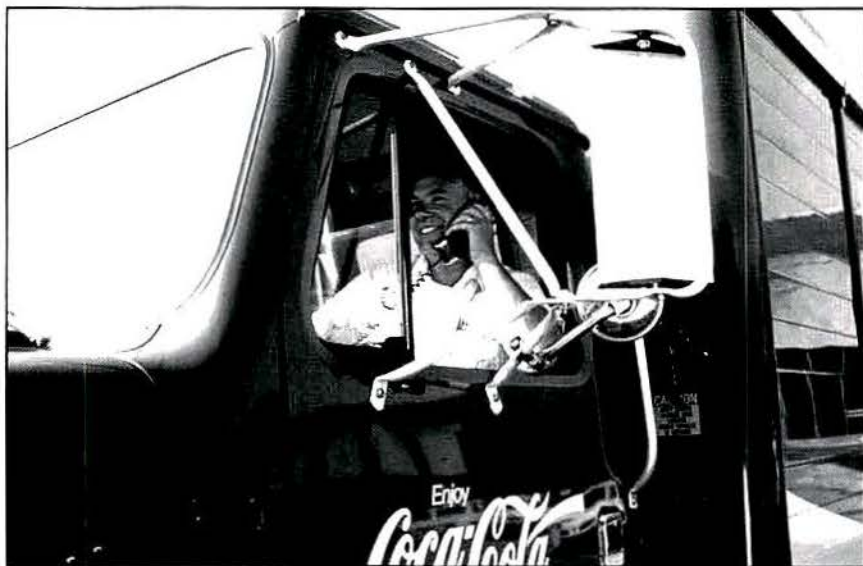
At the same time, privacy was sacrificed, and busy channels caused delay as operators competed for airtime. The driver still needed to stop and find a telephone to call customers and others not equipped with a radio. The typical

community repeater channel supported 40 to 60 mobile units.

As two-way radio use grew, it became apparent that the radio spectrum was being used inefficiently. For example, while competing signals interfered with one another on one channel, a neighboring frequency might be silent. In 1974, the FCC passed regulations that allow an alternative.

► *Trunking*—Originally developed as a way to carry multiple telephone signals over a single cable, trunking was applied to mobile radio in the 800MHz/900MHz band assigned by the FCC in 1974.

A trunked system typically features five, 10 or 20 paired transmit-receive voice channels assigned to users on demand by a computerized control chan-



Drivers used to have to stop and use a pay telephone to conduct real-time voice communications. As early as the 1980s, a driver could make the same call from his cab with a telephone-interconnected SMR mobile.

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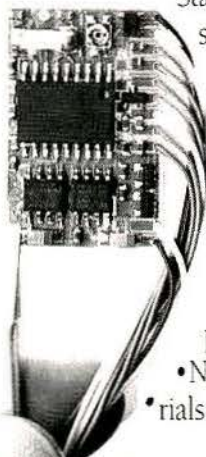
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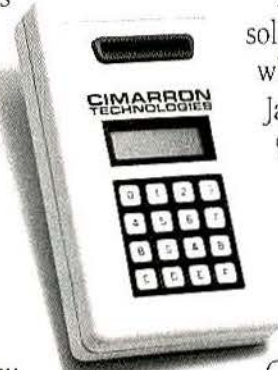
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nel. All mobile units in the communications group monitor the control channel's outbound signal to receive their channel assignments. When communication is complete, the channel automatically is relinquished and made available to another user group.

Trunking offers privacy, speedier channel access and efficient frequency use that supports as many as 125 to 150

mobile units per channel.

► **SMR**—As communication companies used trunking to good advantage, shared communications and dispatch systems known as specialized mobile radio (SMR) were built. Although FCC regulations limited a single SMR system's coverage to a predicted 25-mile radius (many cover greater distances), most metropolitan areas are served by

several SMR systems on different frequencies.

The infrastructure of trunked SMR sites serves more than 1.3 million mobile and portable radios nationwide.

► **Telephone interconnect**—In the early 1980s, telephone industry deregulation resulted in an FCC ruling that SMR systems could be interconnected with the public switched telephone network (PSTN) to extend mobile telephone service to SMR users.

The telephone interconnect made it possible for private, real-time voice communication between mobile units and anyone with a telephone.

Fleet operators had the best of both worlds: time saved by direct-from-vehicle communication and the wide coverage of the telephone network. No longer limited to vehicle-to-dispatcher or vehicle-to-vehicle communication, drivers were able to call customers and

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A round-trip message and response take as much as 15 minutes because the entire country must be served by a single satellite...

supply estimated time of arrival (ETA) and other important information.

Sputnik spinoff

Earth-orbiting satellites require earth-to-space communication for control and navigational purposes and to transfer scientific data. These capabilities have been adapted to provide data communication and vehicle location services to fleet operators. Moreover, non-emergency messages are sent and received through a mobile unit polling process that delays message delivery.

A round-trip message and response take as much as 15 minutes because the entire country must be served by a single satellite with narrow channel bandwidths that reduce data speed to 50 to

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Output voltage:	115 VAC RMS \pm 5%	115 VAC RMS \pm 5%	115 VAC RMS \pm 5%
Output frequency:	60 Hz \pm 2%	60 Hz \pm 0.01%	60 Hz \pm 0.01%
Output waveform:	modified sinewave, phase corrected	modified sinewave, phase corrected	modified sinewave, phase corrected
Efficiency:	90%	90%	90%
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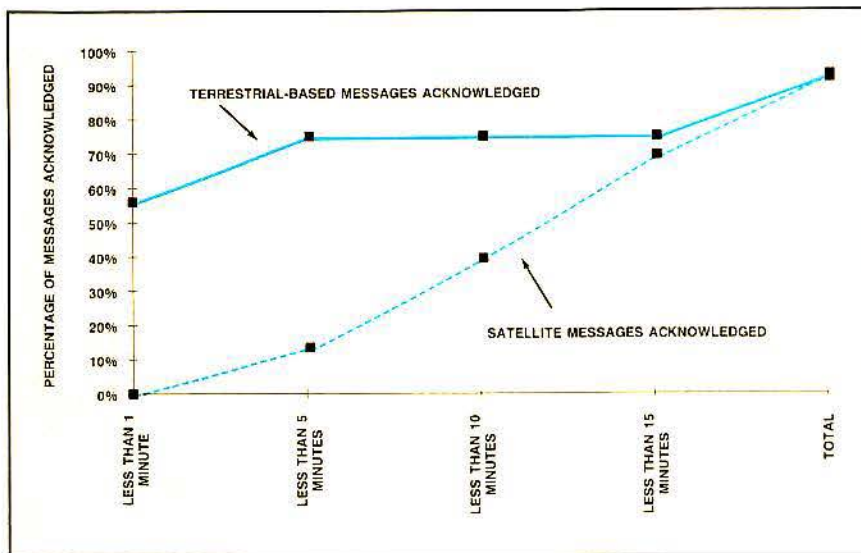


Figure 1. Most messages pass more quickly via a terrestrial-based system than a satellite-based system, as shown in this throughput comparison.

100 bits per second. (See Figure 1 above.)

Thus, although satellite communications systems send and receive data, they do not support a fundamental capabili-

ty that drivers and dispatchers have relied upon since the proliferation of the telephone: real-time voice communication.

In the same manner that SMR systems

were connected to the PSTN to provide mobile telephone service in the early 1980s, in 1990 several hundred were connected to a public switched packet data network (PSPDN). The resulting earth-based network links dispatchers and drivers with real-time voice and data communications. (See Figure 2 on page 30.)

The data move both ways at 4,800 bits per second, allowing nearly simultaneous transmission. Real-time voice communication is via telephone interconnect.

The network consists of SMR sites with nationwide interstate highway coverage, a hub computer and the PSPDN that ties each SMR to the hub.

The PSPDN is linked to a dispatch terminal at each customer location, providing a real-time channel for data messages to and from the radios. Mobile units using the network are programmed to roam automatically, meaning they register onto a string of SMR sites without operator intervention as they travel toward their destinations.

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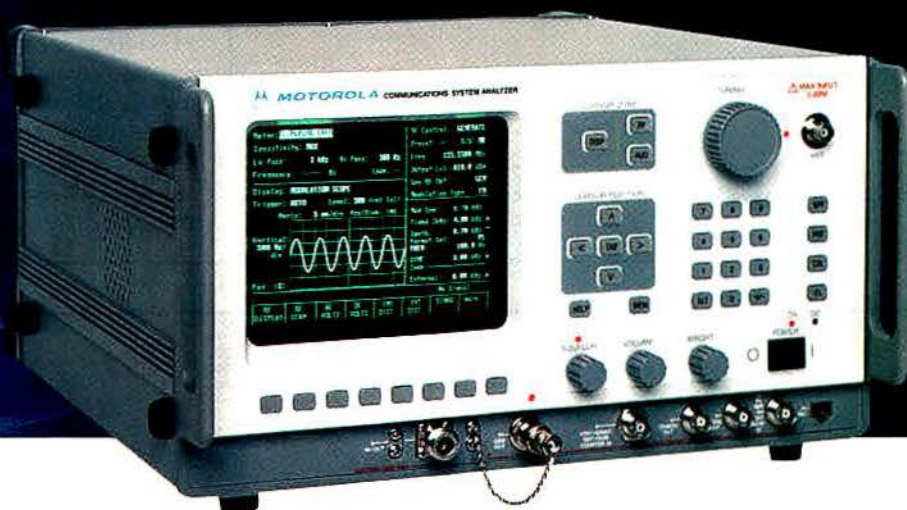
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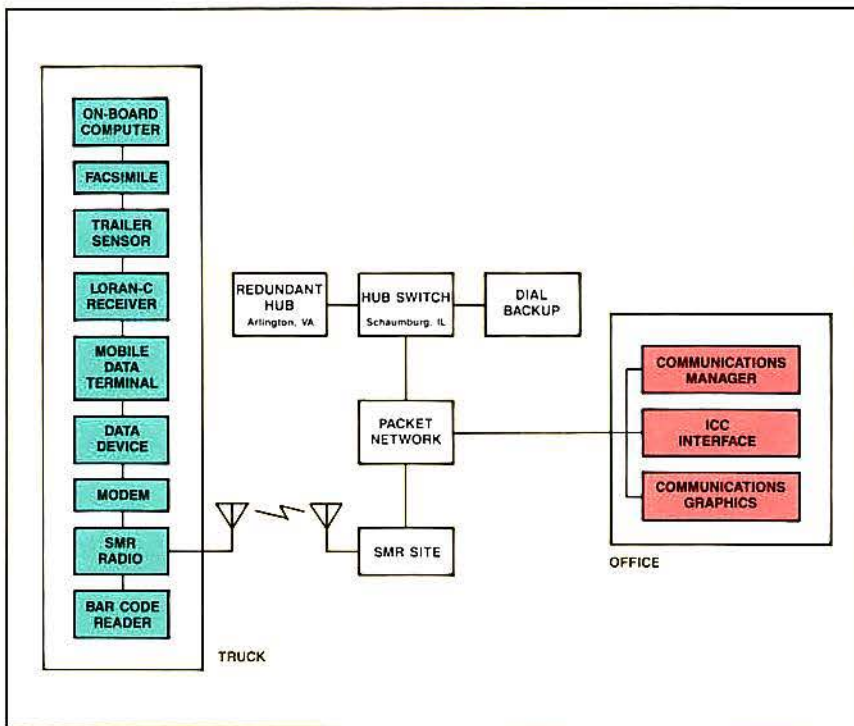


Figure 2. A terrestrial system uses SMR systems and a packet data network to support real-time voice communication, data communication and vehicle location.

► *Roaming*—Mobile units are equipped with software that allows the radio to roam and access any SMR system in the network.

As the vehicle travels, the mobile unit searches and locates an SMR system by scanning for a unique outbound data stream sent repeatedly by all SMR sites in the network. The data stream includes a list of adjacent SMR systems that is retained by the mobile unit and used when it roams out of the current SMR system's coverage.

► *Vehicle loading*—The roaming unit sends its unique ID signal to request registration with each SMR that it contacts, a request that is passed along to the hub computer via the PSPDN.

The hub validates the ID, authorizes access and sends a user control record to the SMR specifying the particular set of communication capabilities that the user is allowed. It sends an update to the dispatcher terminal on the vehicle's new location with a telephone number to use should the dispatcher need to talk with the driver.

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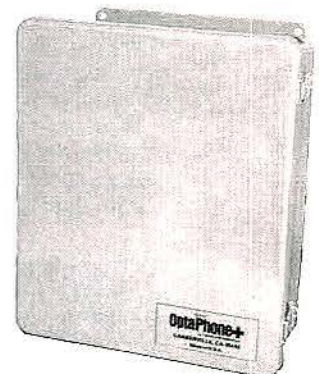
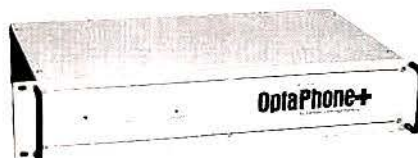
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► *Trunked data adapter*—Hardware modifications made at each SMR site allow two of the voice channels to pass text data over the trunked channel. A trunked data adapter (TDA) switches the voice channel repeater to data capability when a request for a data channel is made.

The central controller sends a signal to accomplish the voice-to-data conver-

sion and removes the channel from the available pool until data messaging is complete, at which time the channel is switched back to voice.

A general communications controller encodes and decodes the data messages and monitors the data channel for data activity.

► *Trunked data controller*—Each SMR site is equipped with a trunked

data controller (TDC) that maintains a database of all roaming users registered on that system. The TDC responds to data requests by sending a command to the TDA to initiate a voice-to-data channel conversion and sends a clear command to return the channel to voice or interconnect availability.

► *Network interface computer*—The network interface computer, as an overlay site controller, acts as a message switch for routing message activity and site information to and from the hub computer. Temporary IDs are created and maintained for each roaming mobile unit.

This information is provided to the hub computer, as well as any billing information regarding communications by the unit. The network interface comput-

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Temporary IDs are created and maintained for each roaming mobile unit.

er provides diagnostics to the hub on SMR site performance.

► *Hub computer*—The network control system, or hub, is a central computer that controls communication traffic between the SMR systems and the customer's dispatch terminal.

The hub performs administrative and billing functions and monitors diagnostic information from throughout the system.

Industry under pressure

The most immediate impetus to apply terrestrial vehicle location and communication technology comes from TL fleet operators. As part of a deregulated industry, TL carriers continue to witness a squeeze on profits. Only the most efficient operators survive as pressure to achieve the greatest possible efficiency increases.

For TL carriers, efficiency consider-

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ations require taking steps to avoid man-hours and vehicle-hours wasted on unnecessary, non-driving activities.

For example, every time a driver uses the terrestrial network's telephone interconnect to avoid stopping to make a call, 20 minutes or more can be saved.

Another way to improve efficiency is by optimizing fleet use when an unexpected order arrives. In this regard, there is no substitute for immediate, real-time communication as the dispatcher tells a driver in the vicinity about a route change.

To add to the pressure, shippers are becoming increasingly demanding customers. Shipping and receiving requires lead time to allocate adequate staffing.

Some customers use just-in-time inventory control. Their costs increase when their goods are received too early or too late. Increasingly, shippers are demanding that carriers make the best use of technology to meet these needs.

Although TL carriers have been the largest market for terrestrial networking to date, other types of fleets are ex-

pected to join the growing network in the near future.

Pickup-and-delivery fleets, river barges and railroad freight haulers are expressing interest, as is a pipeline system operator with many remote, although not necessarily mobile, sites.

*Data communication
works better and generally
is faster than voice...*

Continuing development of data messaging integration into customer software applications will open additional horizons for this flexible technology.

Decision criteria

Every fleet's requirements are differ-

ent, but there are some key issues that any fleet manager must address in selecting the right type of system for vehicle location and communication. Some criteria to consider include:

► **Urgency**—If unscheduled pickup calls, road emergencies and updated ETAs are frequent, the need for immediate communication among drivers, the dispatcher and the customer may make real-time communication a necessity.

► **Complexity**—Data communication works best and generally is faster than voice when the most frequently encountered situations are routine and predictable.

In this type of application, a data-only capability may be adequate.

More complex situations or certain types of emergencies typically require voice communication between driver and dispatcher or driver and customer. People can talk faster than they type, and there may be circumstances that make keyboard use difficult or impossible.

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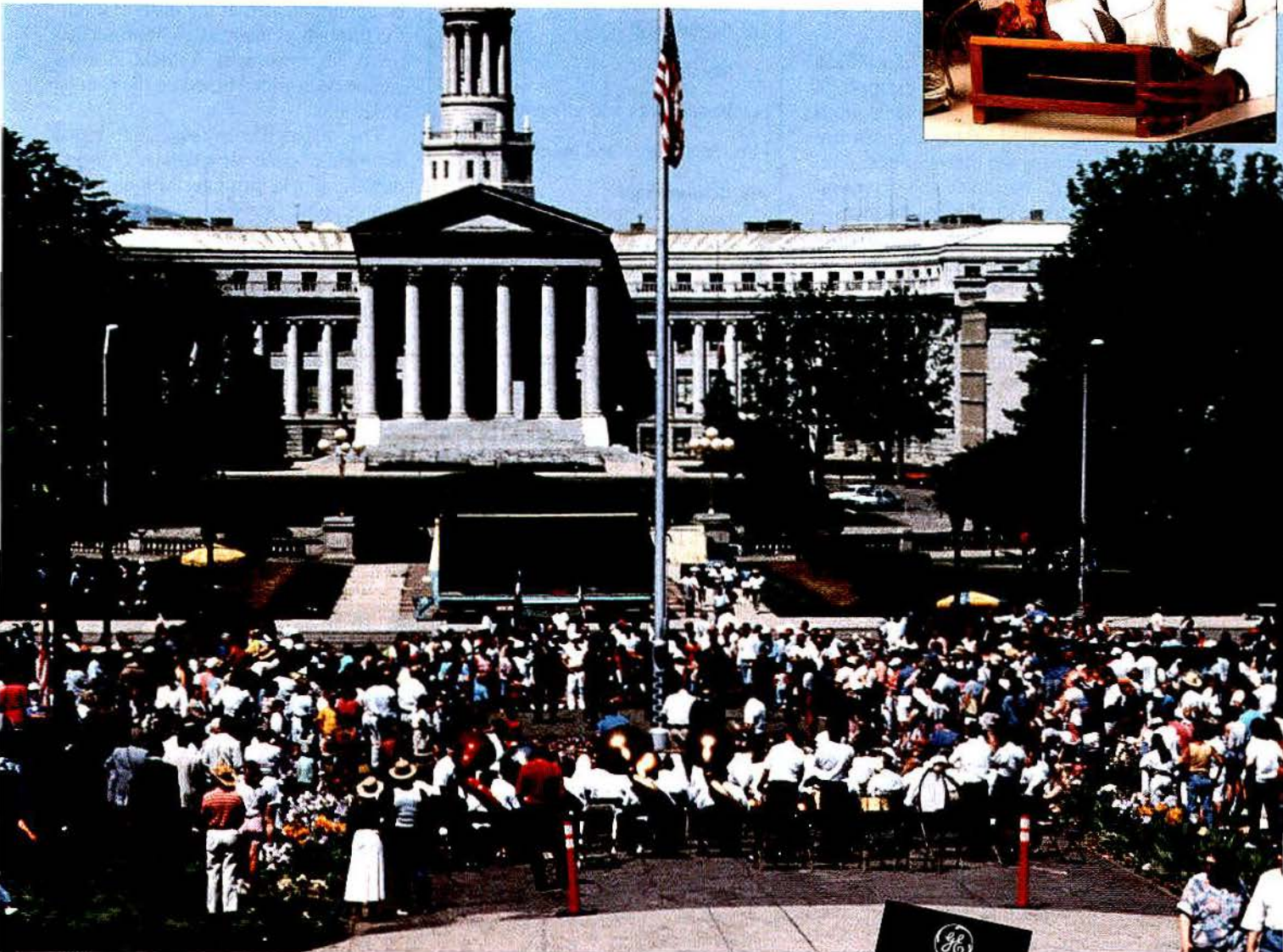
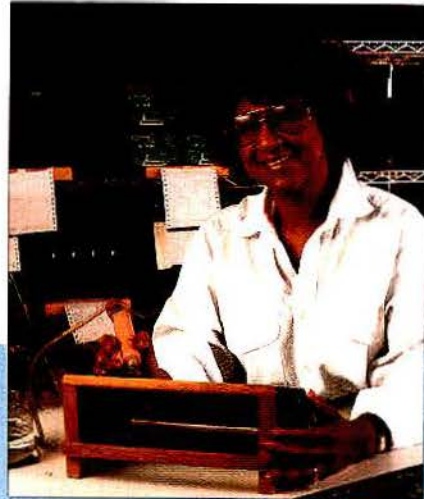
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► **Morale**—In some cases, driver morale may be improved if there is someone to talk to in an emergency. Customer dissatisfaction because of a delayed shipment may be reduced by a personal call originating from the driver advising a revised ETA.

► **Productivity and efficiency**—Each of the above criteria is an example of how terrestrial SMR communications may improve productivity and efficiency by decreasing the time required to respond to both customer and driver inquiries under critical circumstances.

► **Track record and learning curve**—Terrestrial SMR communication has proven itself for more than 10 years, and telephone interconnect has an eight-year track record. They both are reliable, low-risk technologies. The use of satellites in this application is much less extensively tested.

► **Cost savings**—The volume of terrestrial two-way radio use has created a mature technology with strong economies of scale. Equipment and service prices tend to be lower than for satellite-

Decision criteria

- ☐ Urgency.
- ☐ Complexity.
- ☐ Morale.
- ☐ Productivity and efficiency.
- ☐ Track record and learning curve.
- ☐ Cost savings.

based systems, resulting in cost savings.

The types of mobile radios and equipment available to users allow a number of options that can extend the capabilities of the terrestrial SMR network.

A half-duplex radio with a status and message control head provides the most basic way to access the network and use its data capabilities. The dual-tone multiple-frequency (DTMF) signaling capability provides voice communica-

tions capabilities and telephone interconnect via the PSTN.

Communication is half-duplex, with push-to-talk (PTT) switching. Routine and predictable types of situations can be communicated at the push of a button through as many as eight preset status of text messages. Vehicle location can be determined based on the nearest SMR site.

The dispatcher can use map-based software or generate a tabular report to display vehicle locations through a two-way graphic interface.

Full-duplex capability enhances the use of telephone interconnect by providing a more natural, conversational tone without the talk-then-listen inconvenience of half-duplex. Advanced telephone features may be added to provide such standard capabilities as auto-dial, storage of frequently called numbers, automatic call-back, automatic queuing and automatic retry.

For detailed, non-routine message capability, a data terminal with a keyboard replaces the status and message control

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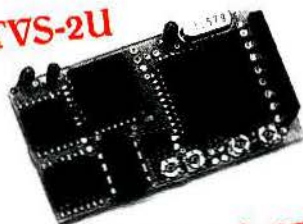
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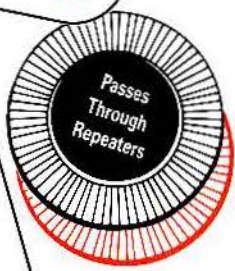


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head. A typical screen display allows eight lines of 40-character text.

Alternatively, a programmed form designed by the dispatcher can be used to prompt drivers for the correct information.

For more accurate vehicle location reporting, a receiver tuned to the U.S. government's long-range navigation (LORAN) system can be used to pinpoint vehicle location within a quarter of a mile.

What's coming

Drivers soon will be able to use data communications without having to type. Facsimile transmission (fax) capabilities are just around the corner.

Fax will allow a handwritten note to be sent and will avoid the need to re-type an existing document, such as a shipping receipt.

The greater bandwidth of the terrestrial network will support fax at 4,800 bits per second.

Digital SMR networks are projected to be built in metropolitan areas by 1993. Total network capacity will be four to six times greater than at present.

Meanwhile, satellite technology eventually will achieve real-time voice and data communication. If and when this happens, a user would need to convert to entirely new equipment to take advantage of satellite communication. Even then, the operating cost advantages of terrestrial networks will be attractive to users for a long time.

Competitive edge

Terrestrial SMR networking is a vital technology for the present and immediate future. It offers substantial advantages over satellite communication for fleet operators.

As communication technology has evolved in this century, fleet dispatchers and their drivers have kept in touch through real-time voice communications.

An earth-based system retains this capability while adding real-time data communication and vehicle location. The result gives fleet operators the competitive edge by saving time for drivers and the dispatcher and improving shipment coordination with customers.



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Intermod and connectors: Silver plate beats nickel

When connectors made entirely of non-ferromagnetic materials are used, they do not have to become the weak link in a communications system, causing harmful and hard-to-find intermod interference.

By Manny Gutsche

Intermod.

The simple mention of the word is dreadful to most two-way radio communications technicians.

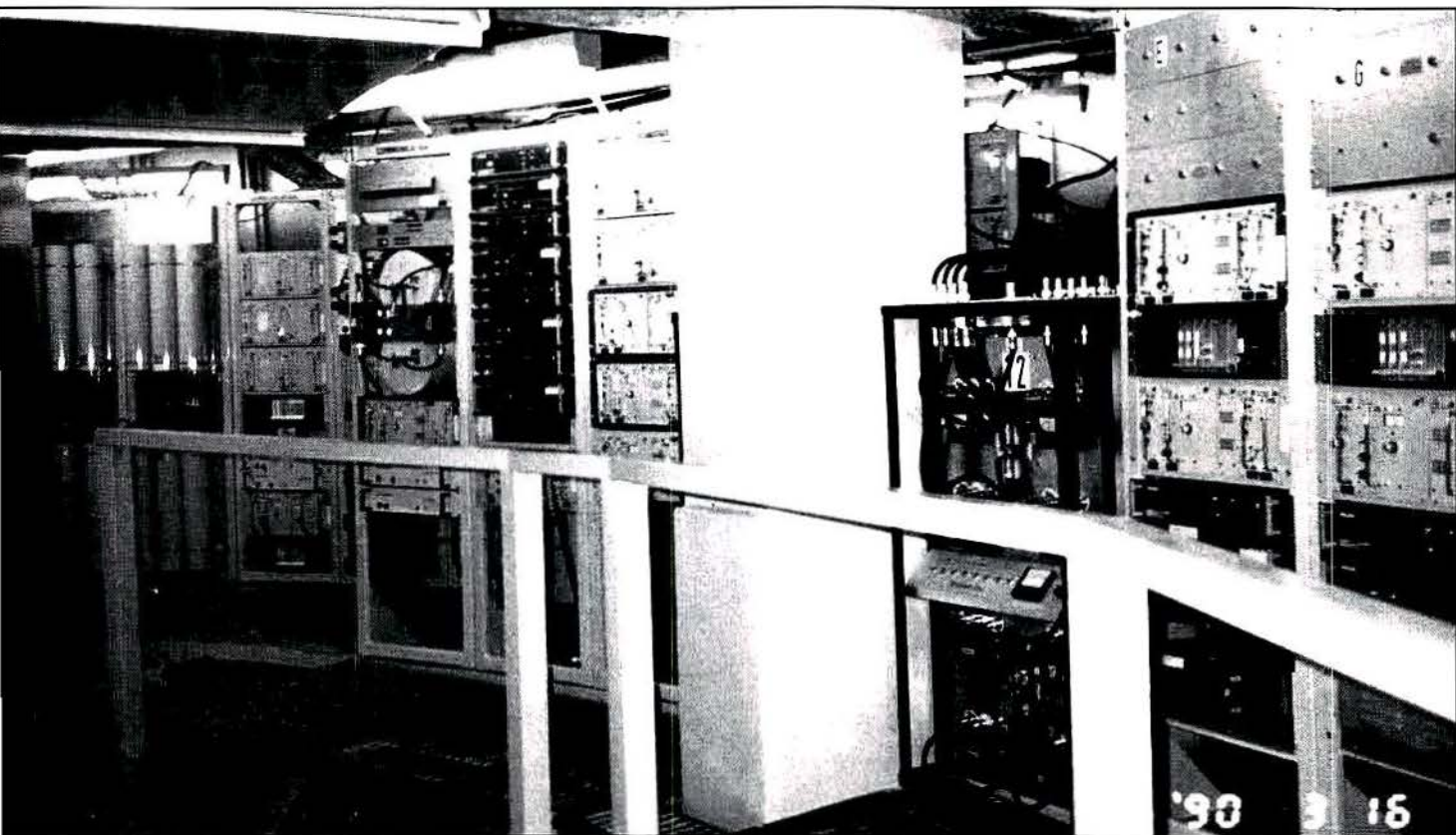
Intermod refers to intermodulation interference, a mixture of two or more signals that results in one or more unwanted

signals disrupting reception. The cause usually is found in transmitters, receivers, transmitting combiners, receiver multicouplers, antenna systems and dissimilar metal junctions near transmitters. Few technicians think to examine coaxial connectors used within the system.

The introduction of 800MHz and

900MHz trunked and cellular communications systems that combine multiple transmitters into one antenna has created the potential for a widespread intermod problem that should be solved before installing a system.

Intermod that can be generated within an active circuit, such as a receiver, can be generated within passive system



Gutsche is sales manager at Grove Technologies, an RF technologies distributor in Las Vegas. When he wrote this article, he was distribution sales manager of RF Connectors, San Diego.

A typical combiner site shows an abundance of connectors. Connectors made with non-ferromagnetic materials, such as nickel, pose a risk of intermod interference. Photo courtesy of Telewave.

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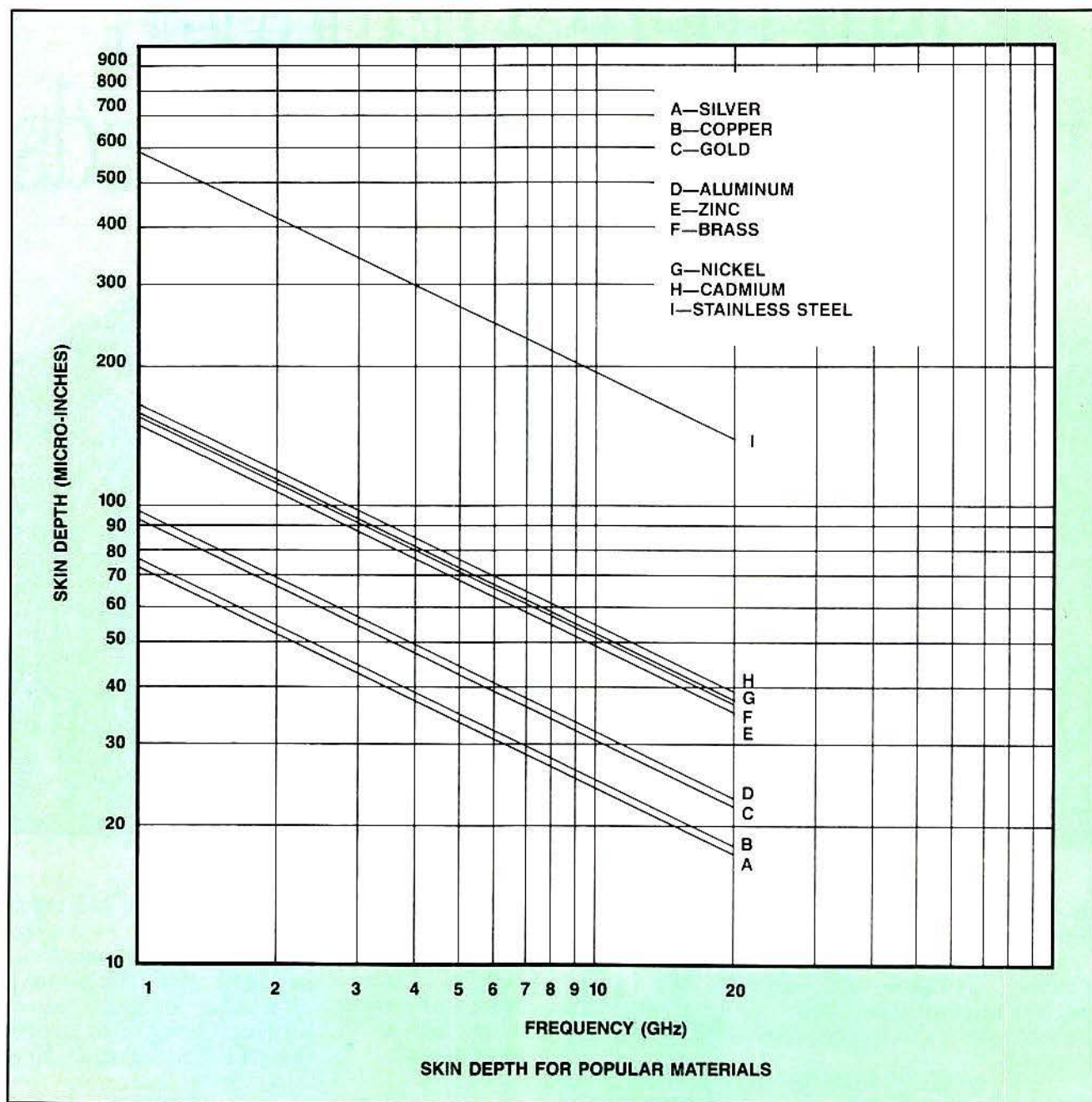


Figure 1. A surprising fact: At frequencies near 800MHz and 900MHz (1GHz, on the graph), most of the radio energy travels within 80 micro-inches of a copper conductor's surface. To put this in perspective, a human hair measures 3,000 to 5,000 micro-inches thick.

components. Any passive component that exhibits a non-linear behavior, including a simple coaxial transmission line, can contribute to the problem.

Understanding how intermod can be generated within a transmission line begins by looking at its electrical and mechanical properties. A properly designed connector is nothing more than an extension of the transmission line. It exhibits the same electrical properties,

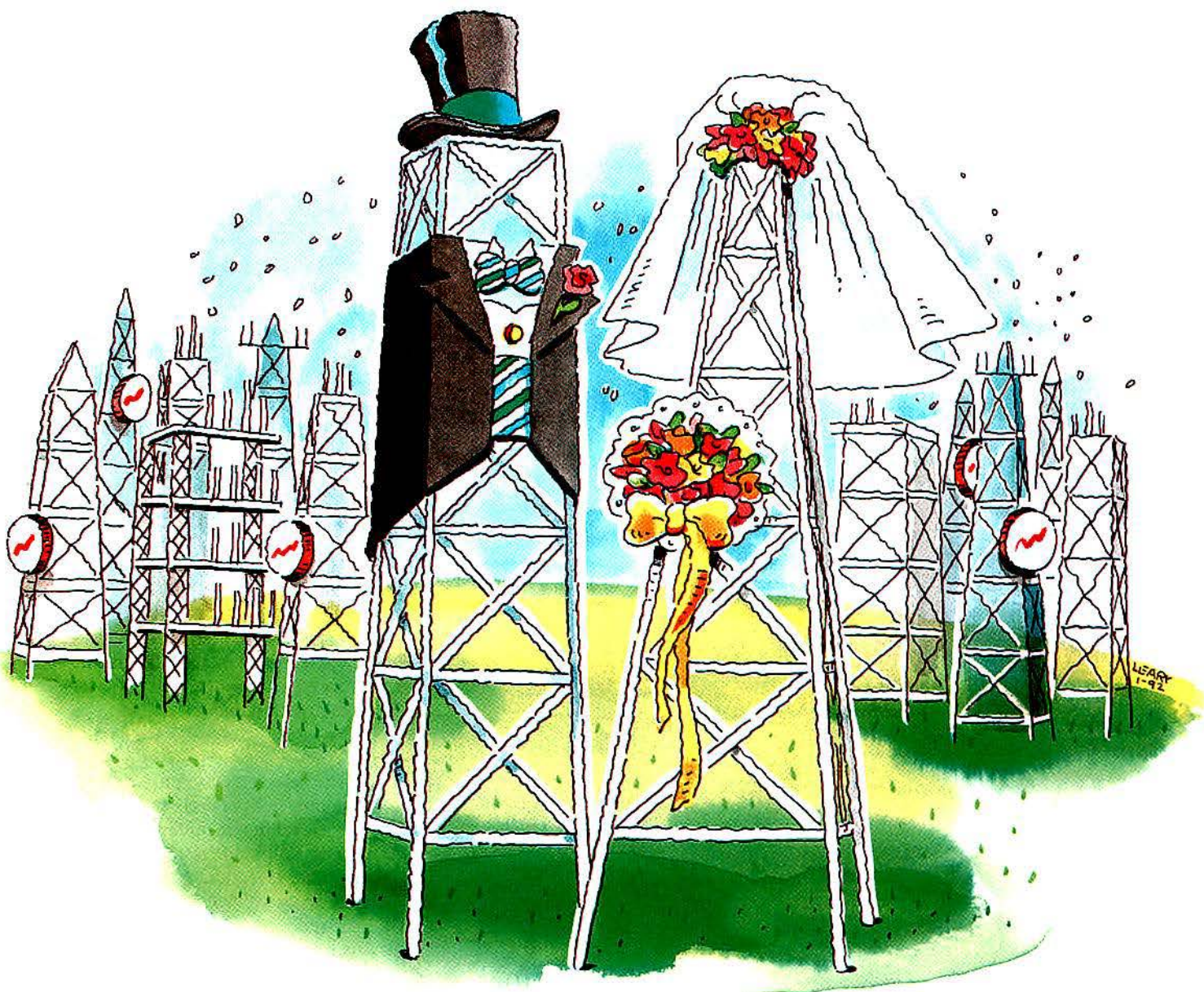
and it can be as important in the initial system design as the selection of the antenna, combiner and transmission line.

When carried by a conductor, radio energy travels along its surface. The higher the frequency, the more pronounced the *skin effect*. Figure 1 above shows a surprising fact: At frequencies near 800MHz and 900MHz (1GHz, on the graph), most of the radio energy travels within 80 micro-inches of a cop-

per conductor's surface. To put this in perspective, a human hair measures 3,000 to 5,000 micro-inches thick.

The *skin depth* for radio energy carried by a conductor is determined by a number of factors besides the radio frequency, including conductivity and permeability.

Conductivity remains constant for a given metal, but permeability varies if the metal is susceptible to magnetism,



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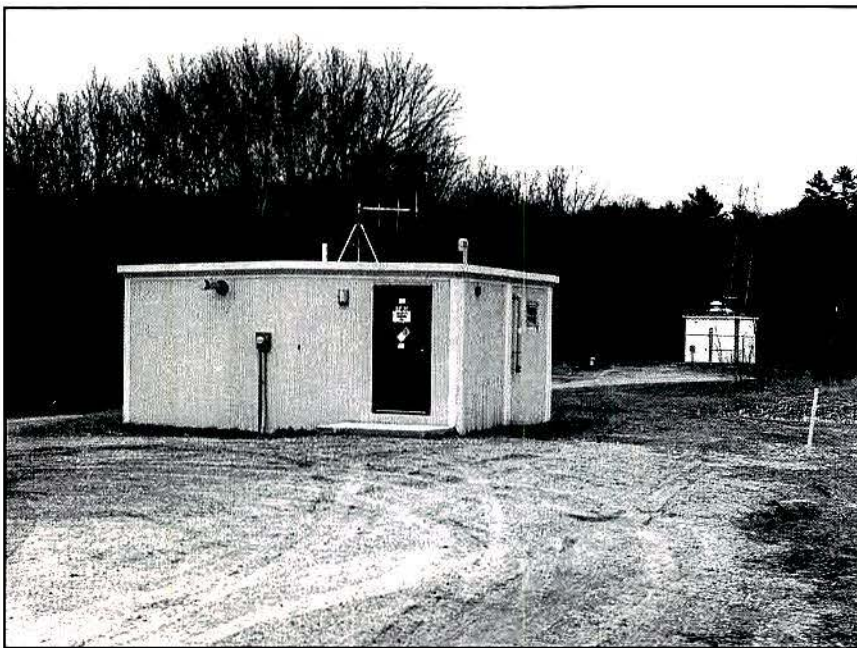


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Getting into SCADA, staying out of trouble

Practical tips for technicians, service managers and dealers help to pave the way for successful installations of supervisory control and data acquisition systems. Examples show pitfalls to avoid.



This typical SCADA site consists of a corrosion control facility with a well building in the background.

By Larry R. Antonuk

The '90s promise to be a turbulent decade in the two-way radio industry. The national economic situation, combined with the advent of non-serviceable, disposable radios, makes for a business environment challenging even to well-established enterprises.

Flexibility is the key characteristic that will distinguish the successful business. The small shop with an ability to diver-

sify into other related fields will be the one to keep its doors open. Whether by selling and servicing alarm systems, telemetry systems, video monitoring equipment or data services, many shops currently spread their eggs among several baskets.

Radio telemetry systems are a natural first step for many shops because the systems often are sold as an offshoot of a shop's current product line. In addition, shop technicians already are familiar with a telemetry system's radio component.

The word telemetry is derived from *telemetering*, which means the metering of some value over a distance.

Telemetry systems monitor analog or status values at a remote location.

The information once was sent almost exclusively by dedicated telephone lines. Radio served the purpose when phone loops were unavailable. Because of phone line cost increases and radio cost decreases, radio telemetry use has become quite popular.

SCADA

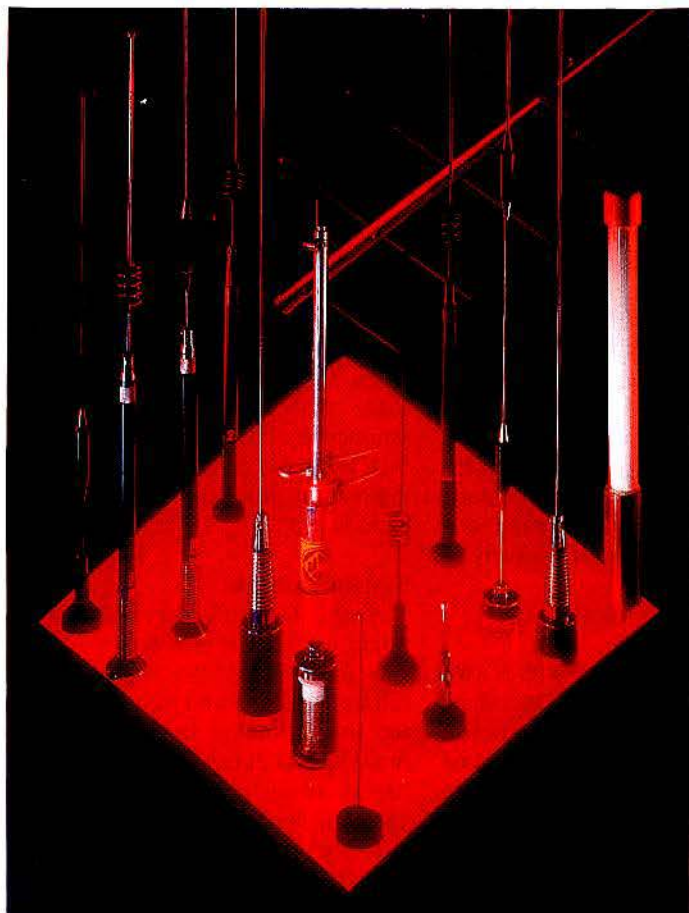
The telemetry system can work in both directions at once, perhaps to monitor a level in one direction and to have a relay follow the status of a switch in the other direction. Such a configuration offers control and value monitoring, and it has come to be called supervisory control and data acquisition (SCADA). Common use of the acronym SCADA refers to various products, including status panels, monitoring and control functions, and synthesized voice reporting, to name a few.

Although SCADA systems have many similarities with conventional two-way radio dispatch systems, from the shop's perspective they differ in two fundamental ways.

First, SCADA systems normally perform all their tasks without human intervention. They make decisions about when to transmit, when to open or close control relays and when to report alarms and failures. A SCADA system normally alerts a person only in case of emergency.

Second, when the shop installs a SCADA system, it has no control over system input and output. For example, a radio shop might receive a contract to replace a 4-20mA water level monitoring system now using a phone line. The

Antonuk is a project manager for R & R Communications, a Motorola service shop in Keene, NH.



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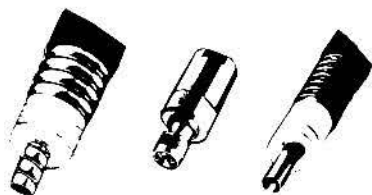
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customer only wants to reduce telephone line charges by substituting radio telemetry. The existing water-level transducer at the tank and the chart recorder at the office are to be retained. The customer should not notice the changeover from the phone line if the radio system is installed properly.

As far as the shop is concerned, it will be dealing with equipment installed and calibrated on both ends of the radio system by another contractor. Perhaps the situation seems straightforward, but it can be the source of major problems. The two ends of the radio system can be responsible for the vast majority of any difficulties.

The basic system

Most two-way shops deal with at least a rudimentary form of SCADA. Many volunteer fire departments use two-tone paging to alert firefighters. The same paging signal often is decoded at the unattended fire station where it switches a relay to activate a siren.

Early status and control systems used a less secure scheme: Single audio tones would turn on a relay, and another tone would turn it off. Although these systems often were protected by continuous-tone controlled squelch system (CTCSS) tones, falsing still was a problem.

When digital logic became affordable, status and control systems were built to send binary words from one station to another. The binary words represented various values. Error-correcting encoding made the transmissions error-free.

In addition to mirroring equipment status at various points along the system, the binary words allowed analog values to be sent. Soon, remote units were made that could decode basic instrumentation values, such as 4-20mA, 0-IV and pulse duration, and reconstruct them at the other end of the communications link.

System example

A small town's water department might use a typical system.

► **Tank site**—At the water tank on a hilltop, a remote unit monitors the water level. Analog measurements are made via a 4-20mA analog loop. Three digital status points serve two float switches that indicate TANK FULL and TANK EMPTY and a door switch that indicates SITE INTRUSION.

► **Pump station**—The pump station at the bottom of the hill has another remote unit with a 4-20mA analog loop and three digital status points. The analog loop monitors water flow. Two of the status points serve control relays that follow the tank's float switch status and

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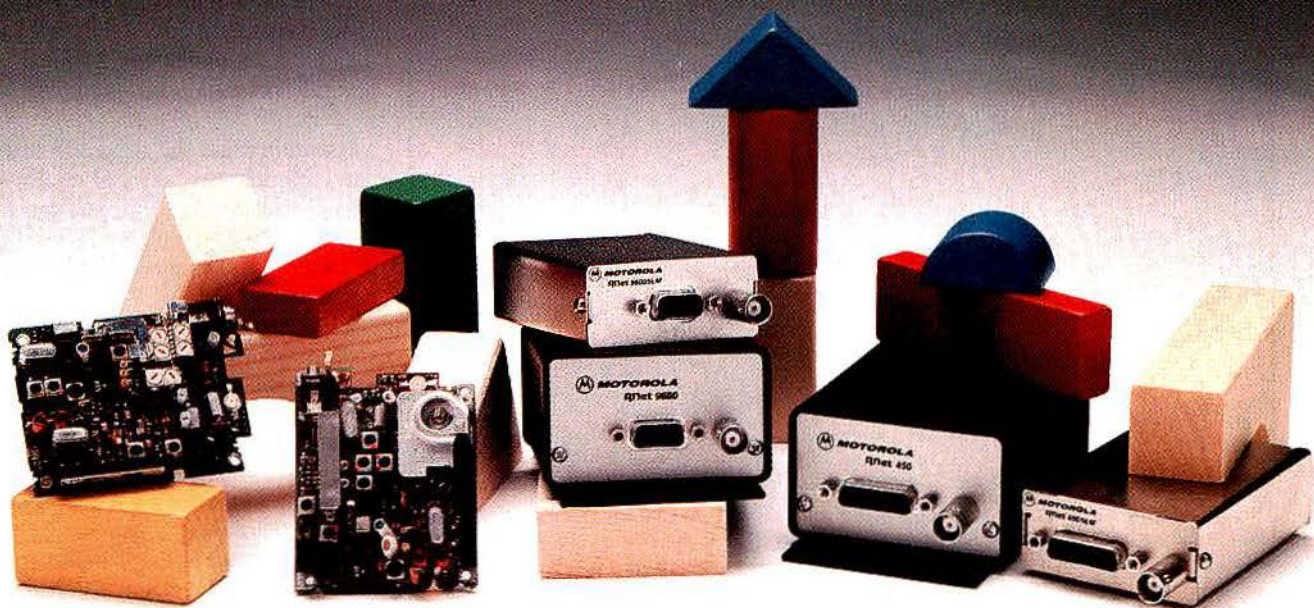
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DTE Interface	RS-232 or TTL
Standby/RX Current Drain	32mA (RS-232) or 27mA (TTL)

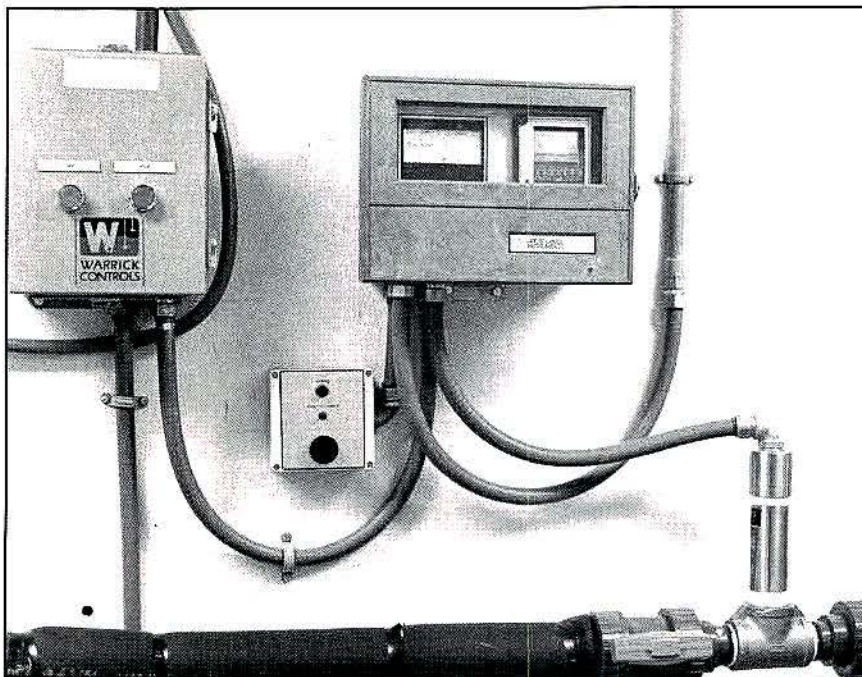


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The cylindrical transducer mounted on the pipe measures the water's PH level. This level is displayed on the analog meter and is converted to a 4-20mA current level that is fed to the radio telemetry equipment.

turn the pump on and off. One status point indicates SITE INTRUSION.

► *Town office*—A master unit at the town office feeds the two 4-20mA analog loops to chart recorders. A status panel monitors the site intrusion points.

At first glance, this typical system looks no more difficult to install than the usual "base and two mobiles." Yet several potential problems become evident.

Assuming that the system is entirely new, the efforts of several contractors must be coordinated. Plumbers must run pipe to the transducers, which must be installed and calibrated by instrumentation contractors.

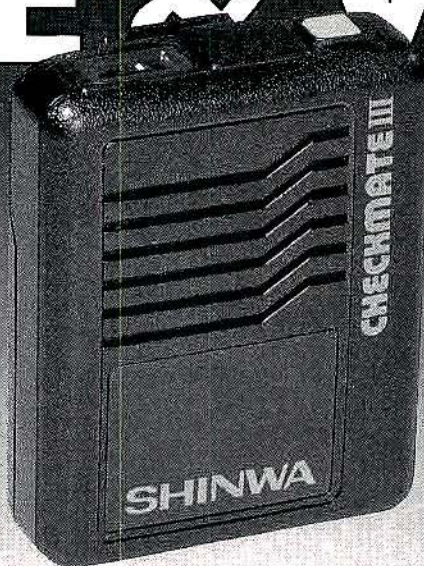
Electrical wiring must be installed, and contactors sized and installed to form an interface between the pump starters and the radio telemetry equipment.

Each of these actions requires the efforts of separate contractors who work according to their own schedules. The two-way shop may complete the radio link installation without being able to test it because the electrician has a \$12

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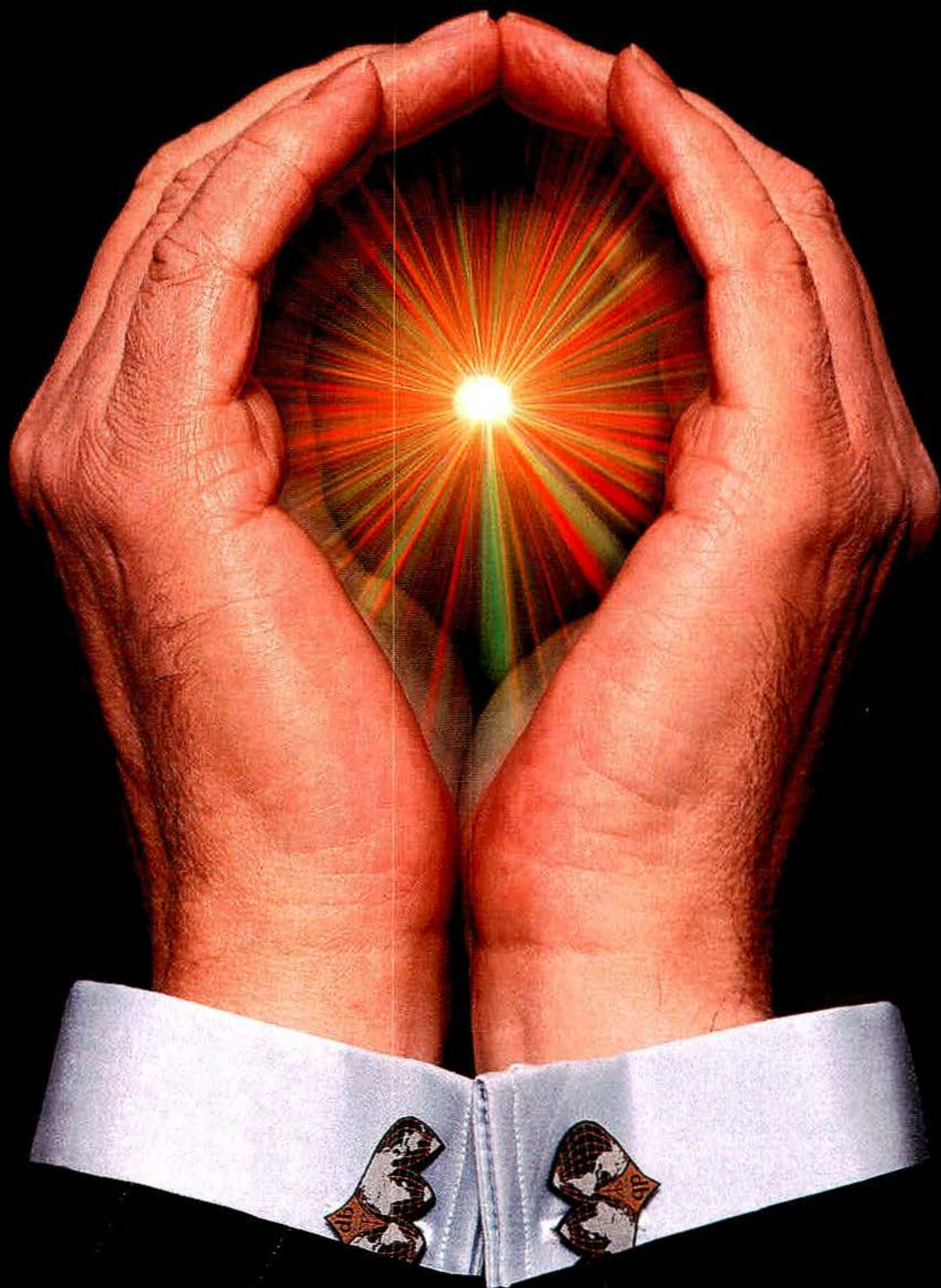
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contractor on back-order. Scheduling often is subject to great uncertainty.

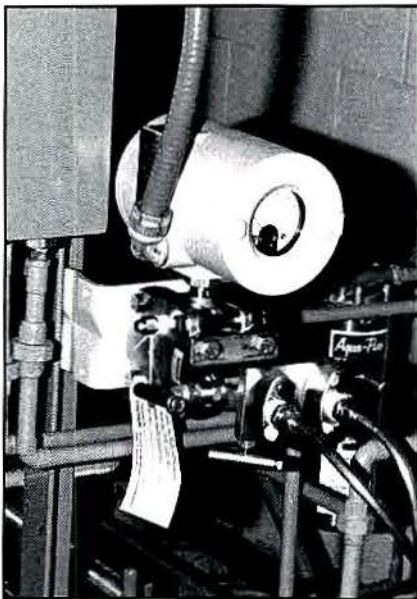
Rule of thumb No. 1: When working against a deadline, always figure that the other contractors will be one-to-two weeks behind. This is a conservative figure.

Common terminology

Multiple contractors often speak different languages. For example, one installation included a solar-powered tank site because no ac power mains reached the hilltop. A building contractor was commissioned to set two 3-inch diameter poles 3 feet apart in concrete near the tank site to support the photovoltaics.

When the radio shop technicians arrived to install the solar panels, clamps and hardware supplied with the panels did not fit the poles. Although the salesman specified 3-inch outside diameter poles, the contractor supplied 3-inch inside-diameter poles. The two-way shop lost time and money as a result.

Rule of thumb No. 2: Get involved be-



This differential pressure flow meter measures gallons per minute (GPM) of water. The two tubes leading out of the front of the device sample the pressure difference on either side of an orifice placed in the water main. The pressure difference is converted to volume and read in GPM.

fore the system is sold.

The days when sales department employees had the technical expertise to write accurate specifications for a job are long gone. As a result, time spent to walk through the site in the beginning of the project stages will be paid back tenfold through avoiding wasted time later. Always check the site, ask questions and take notes.

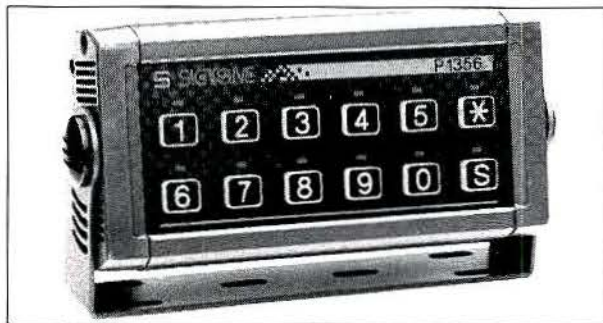
In the solar array installation example, the sales representatives and installers were from the same company. What if they weren't? Who pays for the new hardware or for changing the poles to the proper size? Who pays for the time lost until proper hardware or poles are obtained? These questions usually cause some conflict. The solution is simple:

Rule of thumb No. 3: Get it in writing.

Scope-of-work

With a large project, the customer is likely to have consulting engineers or to have staff engineers write a project description. In this situation, the shop

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will receive a scope-of-work document that lists each contractor's responsibility.

Small projects may be planned by the shop's sales department. Such projects should be described in a letter from the shop to the customer that details the work the shop is to perform and the functions the telemetry system is to provide.

It is not uncommon for a scene such

as this to unfold a week or two after the system is installed:

The customer, not previously aware of a telemetry system's full capabilities, sees a dramatic display in his office. His mind fills with potential uses for telemetry at new and existing sites.

He calls the shop and says, "Say, as long as we have those boxes already installed at the sites, could we add PUMP

ON indicators? LOW TEMPERATURE, if the heater fails? How about WATER LEAK detectors? I think the salesman said you were going to do that anyway...."

Two things can happen.

One, if you wrote a scope-of-work letter, you retrieve it and review it with the customer, noting that none of the additional work he just described is included. You offer to perform the additional work—for an additional cost.

Two, if you did not write a scope-of-work letter, you question the sales representative who sold the project. The sales representative may tell you: "I did kind of mention those things and, well, maybe I did lead the customer into thinking they were included and...."

You get the picture. At times such as this, the scope-of-work document can be your best friend.

Testing

Initial telemetry customers tend to be towns, cities and public utilities. The job sites may be some distance away. Moreover, a given system may include widely separated multiple sites. Testing and troubleshooting will take at least two technicians. The time to discover that one of the analog inputs on Box No. 5 does not work is not when the box has been taken to a distant site.

Rule of thumb No. 4: Always bench-test all of the required functions before the system is installed.

Responsibility

Training classes conducted by radio telemetry equipment manufacturers emphasize separating the responsibility for the radio telemetry unit and the instrumentation. The technician is instructed *never* to touch the transducers, sensors and recorders. He must place a terminal strip between his equipment and the transducers and never cross it. Although this is wise advice, unfortunately it is not realistic.

The small-town water tank example helps to show why. Before conversion to radio telemetry, the system used telephone lines. The technician who installed the present equipment for the town in 1962 retired last year. No documentation is available for the present system.

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OGB3-900 (740-251)	3 dBd	890-960 MHz	V	Radome-protected Collinear Dipole Array
OGB6-928 (740-195)	6 dBd	928-953 MHz	V	Radome-protected Collinear Dipole Array
OGB6-900 (K-7516641)	6 dBd	890-960 MHz	V	Radome-protected Collinear Dipole Array
OGB9-900 (740-189)	9 dBd	890-960 MHz	V	Radome-protected Collinear Dipole Array
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RY-900	10 dBd	890-960 MHz	20 dB	V/H	Radome-protected YAGI
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LP10-900 (K-732261)	10 dBd	790-960 MHz	25 dB	V/H	Radome-protected LOG
BP6-900 (A-6335641)	6 dBd	870-960 MHz	25 dB	V	Radome-protected PANEL
BP9-848 (740-217A)	9 dBd	790-960 MHz	20 dB	V	Radome-protected PANEL
BP11-875 (740-028)	11 dBd	790-960 MHz	20 dB	V	Radome-protected PANEL
BP13-875 (A-633061)	13 dBd	790-960 MHz	20 dB	V	Radome-protected PANEL
BP16-875 (740-215)	16 dBd	790-960 MHz	20 dB	V	Radome-protected PANEL
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an instrumentation expert come and disconnect and then reconnect a few 4-20mA loops? No. The radio shop technician must take the place of the instrumentation expert.

Rule of thumb No. 5: When they said you never would have to touch the instrumentation, they were only kidding.

Learn instrumentation

As long as you are going to work with the instrumentation, find out how it works. Pick up a textbook and learn about dry contacts, status points, 4-20mA loops, analog monitoring and pulse duration systems. The time will be well spent.

In many cases, the two-way shop relays communication between the instrumentation contractor and the customer. You should be in the middle, talking to both. Completely separating the responsibility for instrumentation and radio telemetry equipment may not be practical. For example, the customer does not care whether you can transmit a 4-20mA signal with 0.1% accuracy,

he just wants his FLOW and GALLONS PER DAY data, and he really does not care how you provide it.

Here is a more common example of why the separation between instrumentation and radio telemetry responsibilities is inappropriate. A 4-20mA instrumentation loop consists of a transducer that drives a constant current through a series circuit made up of low-value resistors in various display devices. The voltage drop across these resistors is converted to a value that drives a pen on a chart recorder or that drives a meter movement.

At the pump site, a common equipment configuration includes a FLOW transducer, a digital GALLONS PER MINUTE display and a chemical feed pump. The chemical feed pump injects chlorine or a corrosion-controlling agent into the water at a rate proportional to water flow.

Power supplies for transducers in 4-20mA loops have a limited capability to force enough current through the circuit if its resistance is increased, which it is

when the radio telemetry equipment is inserted in line with the loop. If the telemetry equipment causes the *maximum loop resistance* to be exceeded, the readings become inaccurate and the chemical feed pump does not work properly.

You hook up the telemetry equipment, and nothing works. You disconnect it, and the existing system works fine. Conventional troubleshooting wisdom would indicate the telemetry equipment is faulty, when loop resistance actually is the problem.

At another site, high stray ac voltage levels caused the telemetry radios to transmit incorrect analog data. The ac voltage only became a problem when the loop resistance was increased by the radio telemetry device. In this case, the system worked well when two of the three telemetry devices were in the loop, but not with all three.

The hardware in these two examples individually met specifications—they just did not work when they were connected together. Who is responsible for

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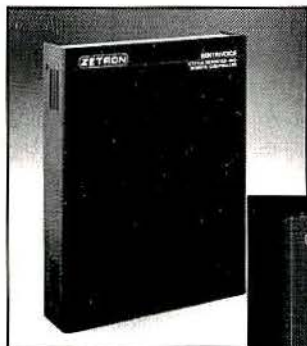
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the problem?

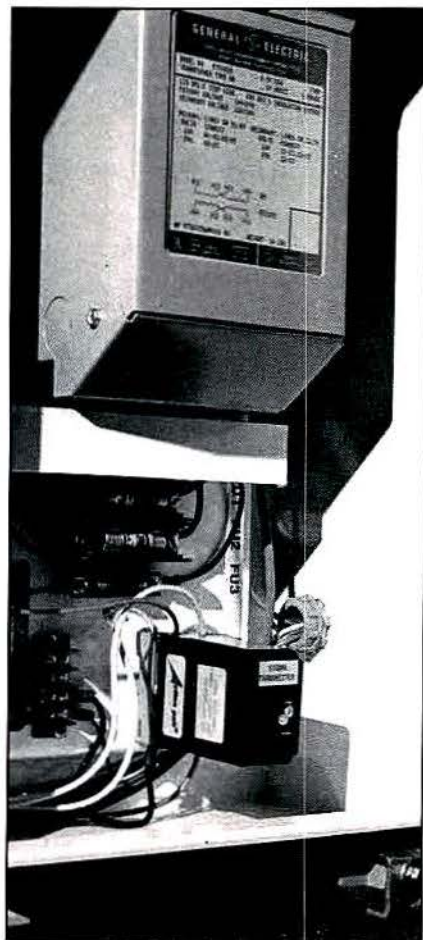
In both cases, a loop isolating transmitter was used to split the analog loop into two separate loops, each with less resistance. Who pays for the loop isolator?

In the first case, if specification sheets are available for all of the equipment, a loop resistance problem can be predicted and the cost of the solution

can be included in the scope-of-work letter.

In the second case involving stray ac voltage levels, it is virtually impossible to predict a loop resistance problem. Even with a proper scope-of-work letter, a problem such as this requires a great deal of diplomacy to solve.

If the tank and water-level pump were installed years before the telemetry sys-



This 4-20mA isolating transmitter (upper right module) was mounted in this chemical feed pump controller to cure an excessive loop resistance problem.

tem, what controlled the pump? The pump may be connected to a timer to fill the tank for a certain number of hours daily. The timer may be connected to a pressure switch that turns the pump on when the water level drops to 6 feet. It is not unusual that the customer cannot tell you exactly what controls the pump.

Dual system

Some customers require the old system to remain in place in case the radio telemetry system fails. The security offered by this arrangement makes sense, but it can lead to confusion. For example, if the old pressure switch activates the pump when the water level falls to 6 feet, it may be tempting to set the new SCADA system to activate the pump when the level falls to 7 feet. The old switch remains inactive but ready to switch the pump on if the radio teleme-

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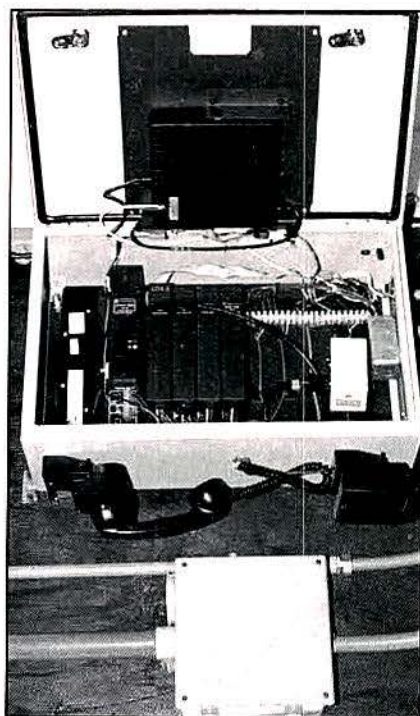
Unfortunately, if the pressure switch becomes intermittent, it may occasionally cause the tank to overflow. The customer is likely to blame the radio telemetry system even if the tank has been overflowing periodically for 10 years.

Rule of thumb No. 6: If the radio telemetry is to operate in conjunction with another system, a means *must* be

provided to isolate the two.

System isolation

The means of isolation should be simple enough for the customer to use it—a toggle switch, for example—and should be labeled clearly and pointed out to the customer. With a means to switch between the two systems, the customer can use telemetry for a week, then the old



All of the status and analog wiring terminates in this radio telemetry cabinet. It houses a 25W VHF transceiver and associated telemetry modules. As configured, the unit handles eight status inputs, seven analog inputs and four control outputs.

pressure switch for a week and compare the two. The separation is essential for initial testing and for subsequent troubleshooting and maintenance.

Testing

With the system up and running, testing should be done. When a "base and two" system is installed, testing each unit is a simple matter: Either it talks or it doesn't.

But with the water system, each site is several miles apart. To "air test" this system, a technician is required at each location. Testing takes time, and it may tie up several vehicles. Each site has several inputs and outputs to simulate or check, a process much more difficult than a "10 count" used to check a small voice radio system.

You can use a 4mA-to-20mA regulated power supply to simulate transducer input and to check whether the charts follow correctly. You can open and close the float switches and the doors, and you can make sure the pump and status panel operates as expected. This procedure may verify that the radio telemetry works properly, but the customer will

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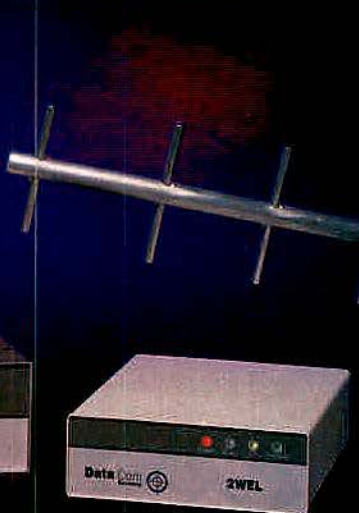
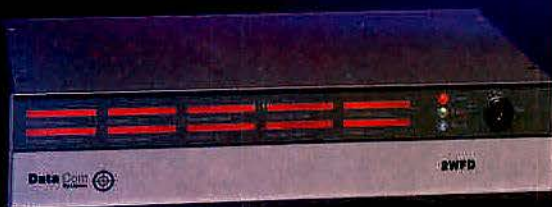
If you have ever had trouble with an RF telephone or data link, you know what a frustrating experience that can be. Even the manufacturer can't provide reliable test methods to users that don't have a 2-way shops worth of equipment.

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Rules of thumb

- No. 1—When working against a deadline, always figure that the other contractors will be one-to-two weeks behind. This is a conservative figure.
- No. 2—Get involved before the system is sold.
- No. 3—Get it in writing.
- No. 4—Always bench-test all of the required functions before the system is installed.
- No. 5—When they said you never would have to touch the instrumentation, they were only kidding.
- No. 6—If the radio telemetry is to operate in conjunction with another system, a means *must* be provided to isolate the two.
- No. 7—Always plan on extra time for optimization and testing.
- No. 8—The customer is always right. He just doesn't always know what he is talking about.
- No. 9—Never buy version 1.00.00.

not be satisfied.

The customer bought the system to fill the tank automatically, and he will not be satisfied until he sees that happen. Depending on the size of the water system, it may take hours or days to fill the tank. Do not assume that one or two cycles of filling and emptying the tank will be enough to convince the customer, either. The average customer wants to see reliable operation for a minimum of one or two weeks before signing off on a contract. For this reason:

Rule of thumb No. 7: Always plan on extra time for optimization and testing.

Customer satisfaction

The customer's office is likely to be at least an hour's drive away from the shop, so expect plenty of telephone contact during the initial testing. Although the high number of telephone conversations may improve your rapport with the customer, reliance on telephone reports may put the shop in a precarious position.

The customer may tell you how the

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system used to work, and his description may be wrong. He may describe a present failure to the best of his ability, but the description may be inaccurate and misleading.

Rule of thumb No. 8: The customer is always right. He just doesn't always know what he is talking about.

Accept the customer's telephone reports, but when in doubt, visit his office. Always err on the side of customer satisfaction.

Software

The most frustrating possible situation is one over which the shop has the least control. It is illustrated by using the small-town water tank installation once again as an example.

The telemetry system has been shop-tested to verify proper operation. It has been installed. The field test results are satisfactory. The pumps are hooked up to the system, and the technicians leave.

The next day, the customer calls because the tank is empty. What could possibly be the problem?

In an actual case similar to the example, the problem turned out to be defective software. A bug in the telemetry equipment operating program caused the remote units to turn themselves off, but only when they operated for a period long enough to fill the tank—about 10 hours.

When the unit was tested with a 4mA-to-20mA current generator, the system worked. But the test lasted only 10 minutes.

When software is the problem, product support from the manufacturer is extremely important. Will the manufacturer correct the software problem and pay the shop to install the revised software?

Maybe it seems as though this type of problem is a rare occurrence, but keep in mind that practically all radio telemetry equipment now contains several microprocessors. Moreover, competition among manufacturers is fierce. Thus, you stand a good chance of "field testing" the latest version of software, especially if you are using a new, cutting-edge option.


Although the technicians often have little say in which specific products are sold to which customers, it is important to know that product choice may be the cause of some strange problems. Remember the programmer's adage:

Rule of thumb No. 9: Never buy version 1.00.00.

Deal with a manufacturer that has a reputation for backing its product, both with warranty repairs and timely field support.

True profits

At first glance, SCADA installation and maintenance appear to be easy money. But as many shops have found, the road to successful SCADA installation can be rocky.

Although some of the problems are beyond the shop's control, many common pitfalls can be avoided. With a solid understanding of the product and its application, the two-way radio shop can proceed cautiously into a new market area and find a product line that is challenging and truly profitable. 

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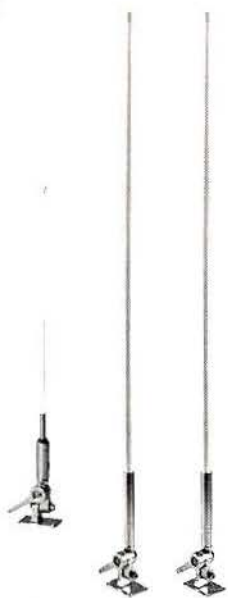
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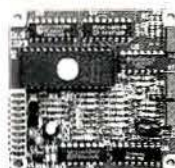
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Simmonds seeks \$5 million from Glenayre, others

Simmonds Communications has taken action against Glenayre Electronics in a lawsuit filed in an Ontario, Canada, court. Both companies are based in Canada.

The suit seeks damages of \$5 million from Glenayre and others based on charges of fraudulent misrepresentation when Simmonds in June 1991 purchased a controlling interest in Overland Park, KS-based Kustom Electronics from

Glenayre.

Specifically, the suit claims Glenayre over-assessed the value of Kustom's Digital Dispatch Systems subsidiary, Vancouver, British Columbia. The action also seeks damages for breach of contract and conspiracy to injure.

Simmonds president John Simmonds and Kustom are also plaintiffs in the action and seek damages.

MasterCard to market Ram data radio network

MasterCard International will market Ram's radio data network to its member financial institutions, according to an agreement signed by the two companies.

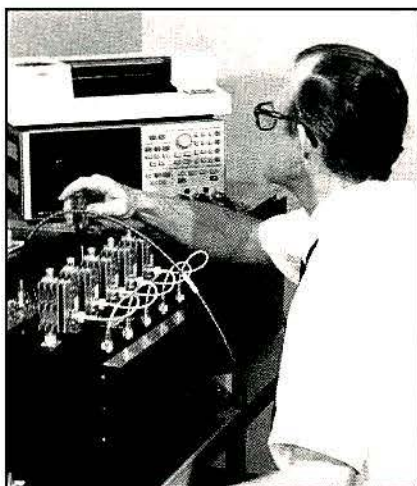
A merchant equipped with a card-swipe terminal can send and receive authorization information by radio via New York-based Ram's high-speed data link.

Avtec receives 4 contracts

Avtec, Gilbert, SC, has received four supply contracts for communications control systems incorporating its ACCESS touch-screen technology. Contracts include:

- ☐ El Paso Natural Gas Company, El Paso, TX.
- ☐ Corpoven, Caracas, Venezuela.
- ☐ Conoco, Lake Charles, LA.
- ☐ Louisiana Offshore Oil Port (Loop), New Orleans.

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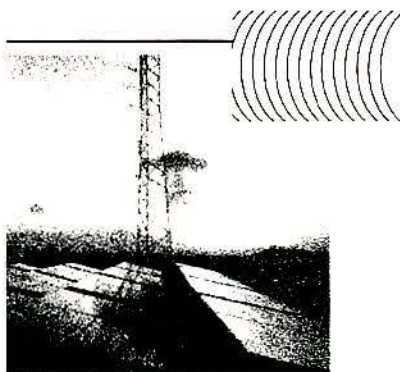
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Technician certification equals high-caliber professionalism

By Thomas Green

In 1984, the FCC eliminated the technician certification requirement in all radio services except marine, aviation and international fixed public.

Knowing this decision would have a major impact on the industry, the National Association of Business and Educational Radio (NABER, of which the Association of Communications Technicians [ACT] is a membership section) conducted a survey of land mobile radio service dealers and found that 87% of the respondents were opposed to the FCC decision.

Clearly, technicians and dealers alike had concerns about maintaining high-quality standards for technicians. In De-

cember 1984, NABER began to administer its much-demanded comprehensive technician exam. By passing this exam, a technician demonstrates a knowledge of, and competence in, working with current mobile communications.

Over the years, the NABER exam has raised the industry's level of professionalism. NABER attempts to ensure that individuals receiving certification enjoy recognition as experts in their field and that they are acknowledged as serious, noteworthy professionals.

According to James J. Comerford, vice president of McKeever Communications, Decatur, IL: "NABER certification demonstrates to my customers that the technician I send to service their equipment is trained in this specialized area of mobile communications.

"Some maintenance agreements I have require me to list each certified technician, including a certificate number. This certification adds a touch of

quality to my company."

Michael J. Miller, system gang supervisor for the Union Pacific Railroad Telecommunications Operations Center in Omaha, NE, said: "The electronic technicians employed at Union Pacific are under certain agreements made between the railroad and the International Brotherhood of Electrical Workers.

"This agreement maintains the integrity of the electronic technician by requiring such a certificate. The NABER certificate allows us to be selective.

"We know that when we hire a new employee who is certified, chances are the employee will succeed at the job.

"Our industry provides our electronic technicians with a challenge. This challenge is met by qualified personnel, thanks to organizations such as NABER that have FCC endorsement and that provide a solid foundation in the electronic industry."

Clearly, technician certification indicates to employers and customers that

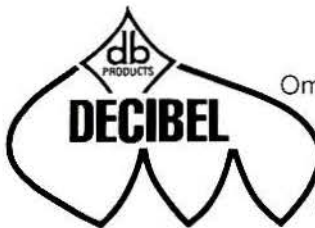
Green is a communication electronics instructor, Ranken Technical College, St. Louis, and ACT's leadership council chairman.



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they are working with a qualified professional.

In addition to meeting or exceeding the high standards set by the industry, it has been proven that technician certification directly benefits the technician. Steve Ambo, service manager at Dechant Electronics, Wood River, IL, stated: "My company pays 50 cents more per hour to the certified technicians. Also, the qualified technician is emphasized in advertisements and in dealings with customers."

Not only can NABER-certified technicians command higher salaries, but they also will obtain a higher level of respect within the industry.

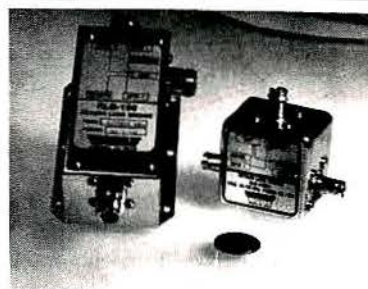
Another major benefit for obtaining certification is that technicians will be able to find jobs more readily. Because a growing number of companies, including Midland LMR, GTE, E. F. Johnson, Motorola, Union Pacific Railroad, Pacific Gas & Electric and Conrail require their technicians to be NABER certified, during recessionary times when employment is more diffi-

cult to find, the certified technician should have an easier time obtaining a new job or switching jobs.

To make sure that technicians know how to keep up with the demands of a rapidly changing technology, it is equally important to the mobile communications industry that recertification takes place. Because technician certification is vital, NABER's certification program requires that technicians obtain recertification every five years.

Another way to keep up your skills is to belong to an association that represents certified technicians' special needs. For instance, ACT is dedicated to enhancing and promoting the competence of technicians.

Technicians who join ACT are kept current about the latest communications technology and are given technical information on how to use newly developed troubleshooting techniques. ACT membership provides the technician with networking opportunities and with the recognition of being part of a nationally respected organization.



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*Items may not be available at locations other than Dallas.



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FCC issues \$9,900 fine for tower light failure

The FCC Common Carrier Bureau's Mobile Services Division has upheld a \$9,900 fine issued to Richmond Cellular Telephone, Richmond, VA. The company was cited for not reporting to the Federal Aviation Administration that the top light on one of its towers was not working.

House and Senate receive matching spectrum bills

Legislation to reallocate 200MHz of federal government spectrum has been reintroduced into Congress in the form of matching House and Senate bills. Any spectrum reallocated under the legislation would be doled out by the FCC to private sector and local government users.

FCC revises application for radio operator license

FCC Form 756, Application for Commercial Radio Operator License, was revised in March 1991. Applicants who use the March edition of the form no longer have to submit completed copies of FCC Form 155 with their applications.

When requesting Form 756 from the commission, applicants should request a copy of the current "Field Operations Bureau Fee Filing Guide." The guide contains important supplementary instructions for mailing applications and paying the fees that must accompany all applications.

The new form is available from the FCC Form Distribution Center, 2803 52nd Ave., Hyattsville, MD 20781 and all FCC field offices.

For additional information about commercial radio operator licenses and applications, call Claudette Jefferson or Gabriel Collazo at 202-632-7240. For information about fees and fee payments, call 202-632-3337.

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Telocator asks FCC to allow private services on cellular

Telocator, a Washington, DC-based trade association, has asked the FCC to modify its rules to authorize cellular carriers to provide private services, such as enhanced specialized mobile radio (ESMR). Although one company, Fleet Call, has been granted FCC authority to construct ESMR systems, none has been built yet. As described in Fleet Call's application, ESMR would offer two-way radio dispatch and mobile telephone services.

The American Mobile Telecommunications Association (AMTA), whose membership includes specialized mobile radio (SMR) operators and ESMR applicants, opposes the Telocator request.

Citing a previous FCC decision in a similar proceeding, AMTA president Alan Shark said that the FCC agreed that the proposal to permit dispatch service on cellular spectrum would violate the Communications Act. "Neither that FCC decision nor the act can be read to indicate that the prohibition may be evaded simply by relabeling that portion of the cellular operator's business," he said.



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Cellular Business
Magazine, and Mobile
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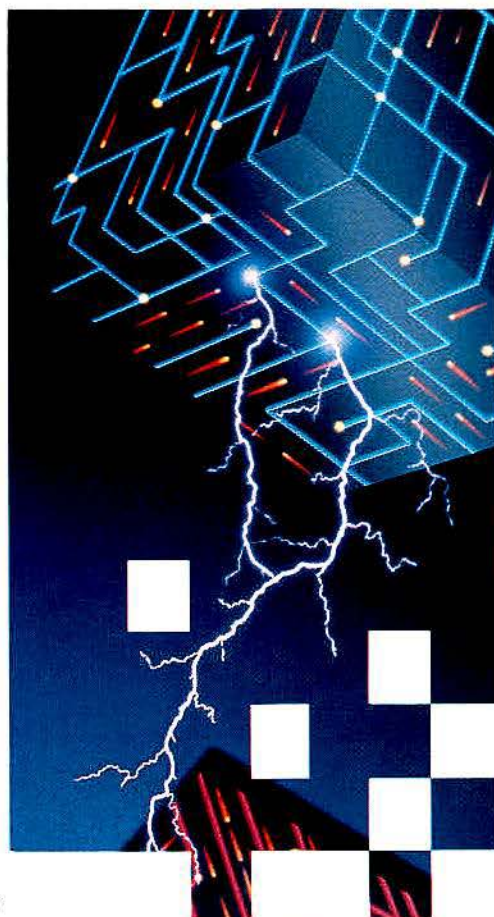
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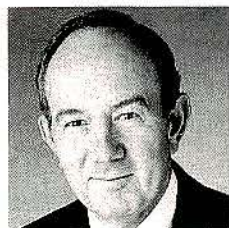
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William Blatt, Assistant Vice President, Technology Planning, Northern Telecom
Joel Engel, Vice President of Technology Management, Ameritech Services
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John Wickens, President, PA Consulting
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Readers' choice

Of all the new products and services in the July issue, the ones reprinted here generated the most reader requests for additional information. If you missed them the first time, here is your opportunity to acquire more information on them: Just circle the corresponding Fast Fact Card number on the card found in the back of this issue and mail the card to us.

High-power attenuators boast 200W rating



High-power attenuators and loads from **JFW Industries** are rated at 200W average and 5kW peak. The units require no external cooling and are available from 0.5dB to 50dB. The modules include a handle for moving.

Circle (515) on Fast Fact Card

Multitone encoder selects discrete tone from memory

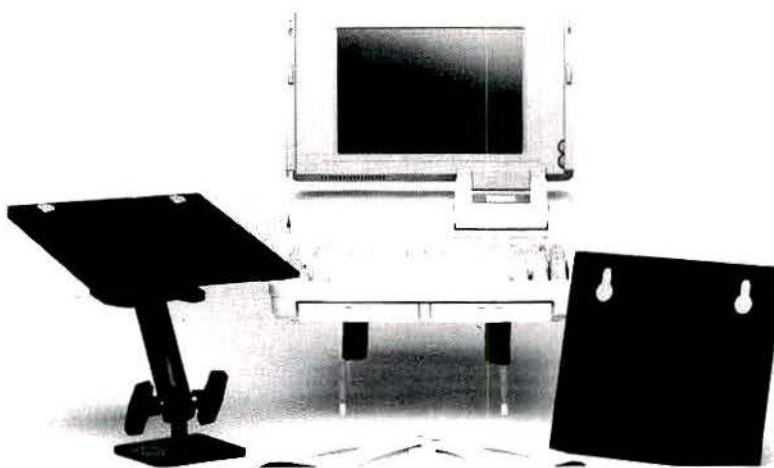
A miniature multitone encoder permits the selection of a discrete CTCSS or burst tone from a custom 12- or 16-tone memory. The tone activates via a rotary encoder switch mounted on the board. The **Communications Specialists** versions SS-12 ND SS-16

boards allow factory programming of 12 to 16 tones into the EEPROM before shipment. The encoder suits most panel-mount installations in base stations and many mobiles.

Circle (514) on Fast Fact Card

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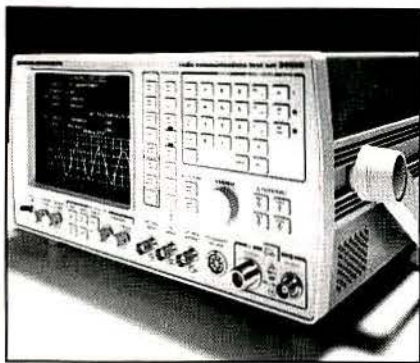
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Circle (72) on Fast Fact Card

Test set suits benchtop, mobile field service uses



Model 2955B radio communications test set features improved residual FM specifications that allow measurement of as high as 60dB receiver signal-to-noise ratio. The **Marconi Instruments** test set provides facilities for testing AM, FM and OM radios; full-duplex radiotelephones; POCSAG and digital pocket pagers; and base stations and repeaters. The unit suits benchtop and mobile field service applications.

Circle (395) on Fast Fact Card

Coaxial lightning protector covers C band



Model IS-MC50LNZ+24 coaxial lightning protector operates in receive-

only mode when the low noise amplifier is being powered up by the coax lines. The C band protector from **PolyPhaser** protects 24V of direct current and has a voltage wave ratio of less than 1.2:1. It comes standard with type N female fittings.

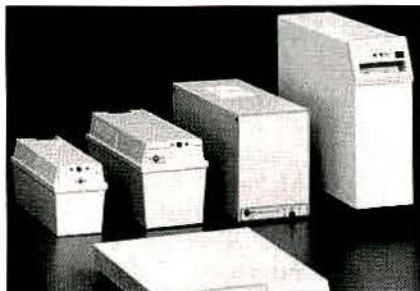
Circle (339) on Fast Fact Card

Headset features throat mic, non-occluding earmold

The neckset headset from **Television Equipment Associates** comes with a non-occluding earmold. The headset has a throat mic that picks up voice but does not transmit background noise.

Circle (373) on Fast Fact Card

Uninterruptible power line spans 180W to 4,000W



An expanded line of uninterruptible power systems from **Tripp Lite** includes standby battery backups from 180W to 4,000W. The UPS line includes intermediate-size UL listed units, as well as voltage-regulated UPS systems.

Circle (305) on Fast Fact Card

14-channel VHF portable meets military specs

Model EPH 514 OA 14-channel portable from **Bendix/King** operates in the 148MHz-to-174MHz range. The VHF hand-held features a 100-channel-per-second scan rate, programmable transmit power, DTMF automatic numeric identifier, scan delay, busy channel lockout and battery-saver. The radio may be programmed by a PC or by cloning from another radio. The transceiver meets military standard 810C and D, as well as EIA and U.S. Forestry Service shock and vibration specs.

Circle (385) on Fast Fact Card



Replacement batteries fit various transceivers

Replacement batteries are available from **W&W Associates** for various radios.

□ Two replacement battery packs are available for Oki-900 cellular telephones.

□ Two replacement packs and a battery eliminator are available for the Panasonic EB-H30 cellular phone.

□ A replacement battery and a bat-

tery eliminator are available for the Audiotex PR-100 Prestige cellular telephone.

□ A 7.2V, 700mAh replacement battery is available for Nokia Mobira PT612 cellular phone.

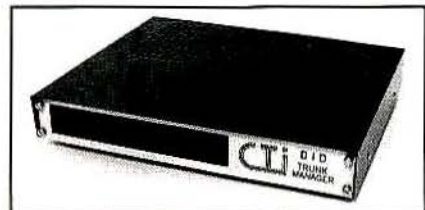
□ A replacement battery and eliminator are available for Ericsson's Pocket Hotline cellular telephone.

□ Models WC-500 EBP-10N 7.2V and 700mAh battery and model WC-505 EBP-12N 12V and 700mAh battery replace Alinco batteries.

Circle (375) on Fast Fact Card



DID trunk controller serves RCC, PCP uses



The DID Trunk Manager enables efficient use of input trunks, operating as an interface between the incoming DID

trunks and any type of equipment requiring a telephone line input, either DID or DTMF. The CTI controller accepts as many as three DID telephone trunks and steers each individual number to any one of five output ports. The trunk controller suits RCC and PCP operators that want to share two or three DID trunks among paging, mobile interconnect and voice mail.

Circle (352) on Fast Fact Card

New products

Frequency synthesizers boast fast switching

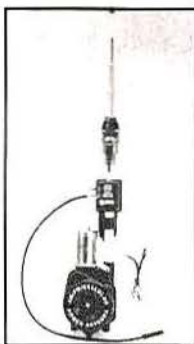


Frequency synthesizers from **Anritsu** feature switching speeds as fast as 5 μ s, depending on the control interface. Model MG2501A covers 1MHz to 300MHz, and model MG2502A covers 1MHz to 600MHz. Model MG2502B offers front-panel operation and digital sweep of memory locations, as well as dual sweep.

Circle (245) on Fast Fact Card

AM-FM cellular antenna installs on fender

The CMX1050 AM-FM cellular power antenna offers 3dB gain, low VSWR and wide bandwidth in its cellular mode. The **Ora Electronics** antenna mounts on a vehicle's fender and features a retractable design.



Circle (493) on Fast Fact Card

Cellular phone mount comes in 4-inch version

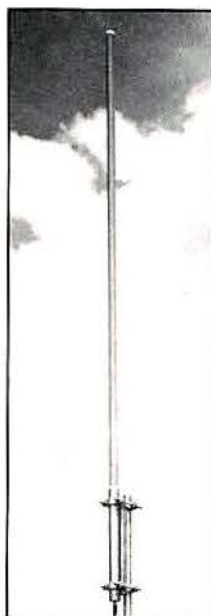
A 4-inch cellular phone mount is available from **PanaVise**. The mount is available in set-screw and knob adjustment configurations.



Circle (355) on Fast Fact Card

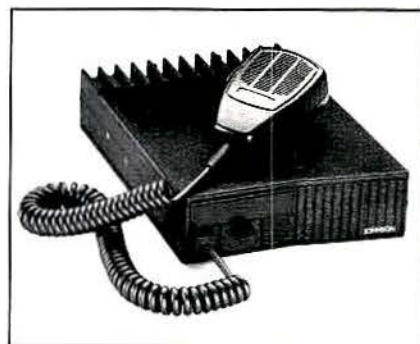
Base station antennas sport 2-inch radomes

Omni base station antennas with 2-inch fiberglass radomes from **Decibel Products** suit 806 MHz to 960 MHz applications. The 9dBd and 10dBd gain antennas feature maximum power input of 450W. The DB809M and DB810M come with or without 3° or 6° uptilt or downtilt.



Circle (389) on Fast Fact Card

Retrofit kits update mobiles for network use



LTR AmeriCom networking retrofit kits allow existing **E. F. Johnson** LTR series 8600 mobiles to be used on the AmeriCom network. The upgraded mobiles handle roaming with automatic check-in; over-the-air programming and updates; unique ID calling; and storage of frequently used numbers.

Circle (237) on Fast Fact Card

Battery conditioning system targets consumers



The MC-01 Discovery battery conditioning system is aimed at consumers for recharging nickel-cadmium batteries used in Motorola 8000, 950 and Ultraclassic cellular telephones, as well as other compatible cellular telephones. Made by **Surecharge Industries**, the conditioning and recharging system increases the life of NiCd batteries by a minimum of five times more than that expected by conventional charging methods. The system maintains 100% of the rated energy every time a battery is conditioned.

Circle (307) on Fast Fact Card



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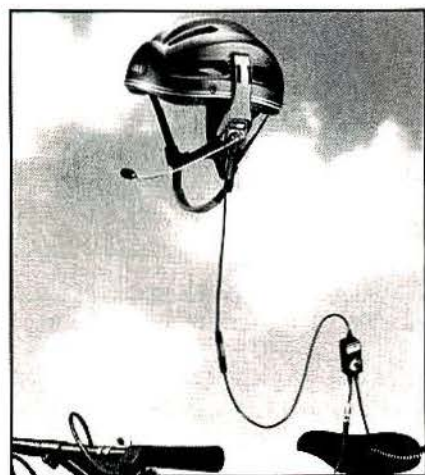
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Circle (73) on Fast Fact Card

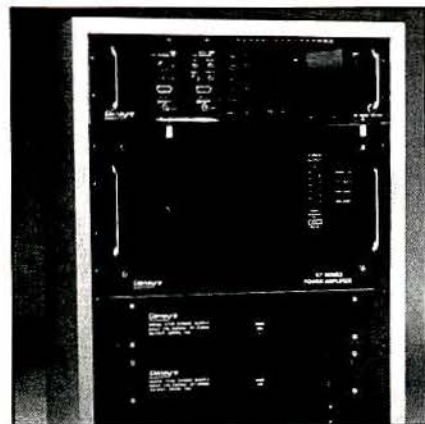
Bicycle helmet package includes mic, PTT switch

The bicycle helmet Comkit from **Setcom** includes a three-part system with a mic, built-in speaker and cable assembly that interfaces to a portable radio. The system includes a handle-bar PTT switch. The package easily mounts on a variety of bicycle helmets.



Circle (342) on Fast Fact Card

Repeaters, base stations solve heavy traffic loading



FM base stations and repeaters operate in the 138MHz-to-174MHz and 406MHz-to-470MHz bands. The **Glenayre Electronics GL8000** series sport a modular design and solve problems such as heavy traffic loading, equipment crowded transmission sites and congested frequency spectrum. The units operate with power outputs of 4W, 125W/150W and 250W in a continuous duty cycle.

Circle (345) on Fast Fact Card

Wideband receiver scans up to 35 channels per second

The SR001 wideband receiver from **Shinwa Communications of America** covers 25MHz to 999.999MHz with continuous scanning. Features include scan of as many as 35 channels per second; programmable indicators and alerts; LCD; front-panel or remote control selection of frequency and mode; and 200-channel memory.

Circle (365) on Fast Fact Card



2-channel VHF portable delivers 5W output

The two-channel VHF portable radio from **Tekk** boasts a low cost and 5W output. The radio features ceramic tuning capacitors, machined aluminum controls and an audio accessory plug.



Circle (397) on Fast Fact Card

SMR management software helps with invoicing

The EzBillTR SMR management software suits E. F. Johnson's trunking format and enables straightforward invoices. The **Genesis Group** software automatically bills fixed charges, dispatch and telephone airtime, as well as other items as dictated by the system manager.

Circle (390) on Fast Fact Card

Network software reduces public usages fees

The RF/Compress software from **RF Data** reduces network usage fees on public networks and increases throughput on public and private networks. The software's compression routine enables effective data transmission.


Circle (374) on Fast Fact Card

Replacement batteries fit Motorola radios

NiCd replacement batteries are available from **JaBro Batteries** for Motorola MT1000 radios. The batteries are dark gray at 9.6V. Model JB4822 and JB4824 replace Motorola NTN4822 and NTN4824 respectively. The JB4868, JB4869 and JB5447 replace NTN4868, NTN4869 and NTN5447 respectively.

Circle (348) on Fast Fact Card





NUMERIC

uniden

- VHF, UHF, 900 MHz
- POCSAG signalling format
- Holds up to 16 messages
- 128 Character memory
- Selective message delete
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Circle (77) on Fast Fact Card

New products

Programmable portables boast switchable output

The MX series FM portables from Midland LMR feature 5W output power that is switchable to 2W. VHF model 70-145MX covers 138MHz to 174MHz in three frequency ranges. Model 70-245MX UHF portable covers 406MHz to 512MHz in four frequency ranges. The hand-held models are programmable for as many as 16 channels and meet military standard 810C and D. Intrinsically safe models are available.



Circle (281) on Fast Fact Card

TDD module mounts in 9-1-1 console



Model 3030 telecommunications device for the deaf (TDD) mounts inside a 9-1-1 console for public safety dispatching. The module is compatible with shared TDD and voice lines and available from Zetron.

Circle (382) on Fast Fact Card

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Circle (74) on Fast Fact Card

Catalog lists antenna equipment

Base antennas; cables and connectors; cavities and filters; duplexers; transmitter combiners; receiver multicouplers; Sentry 8000 monitors; VHF, UHF, 800MHz and 900MHz RF power amplifiers; and fiber optic signal distribu-

Circle (401) on Fast Fact Card

Handbook explains grounding connections

How to make and inspect Cadweld grounding connections is detailed in the pocket-size handbook from **Erico Products**. "Installer's and Inspector's Guide

Circle (404) on Fast Fact Card

Directory provides antenna tower sites

Fryer's Site Guide lists more than 50,000 antenna tower sites nationwide. The six-volume directory includes maps, cross-reference indexes and editorial information to assist readers in making site selection. The guide by **Dean Brothers Publishing** includes

tion systems are included in **Decibel Products'** Catalog 23. The 224-page publication has sections on applications and engineering including systems design and radiation management information.

for Cadweld Electrical Connections" describes inspection techniques for qualifying connections in the field. A troubleshooting section is included.

Circle (406) on Fast Fact Card

Brochure details UPS systems

On-line, standby, ac line regulated, network and special application systems are detailed in **Tripp Lite's** UPS systems brochure. The eight-page publication lists product lines and technical specifications.

Circle (403) on Fast Fact Card

Brochure describes neckset headset

Neckset headsets for use with two-way portable radios for fire entry and Hazmat applications are described in **Television Equipment Associates'** brochure. The neckset consists of a throat mic and non-occluding earmold for the receive signal.

Circle (213) on Fast Fact Card

Catalog features telemetry products

Transmitters, receivers, RF modems, synthesizers and turnkey telemetry subsystems are described in **NCI Systems'** catalog. The products can be designed for 25MHz-to-20GHz standard configurations or custom subsystems for specific applications.

Circle (208) on Fast Fact Card

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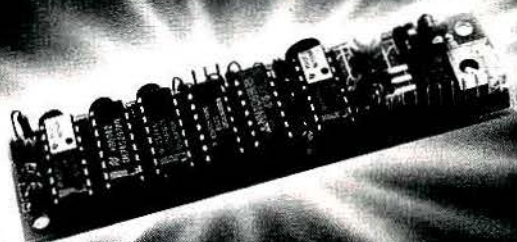
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Circle (79) on Fast Fact Card

Radios become 'more difficult' to service

Radios are becoming more difficult to service, according to 80.6% of the respondents to the August 1991 "What Do You Think?" questionnaire. Surface-mount devices (SMDs) and unique designs that vary from manufacturer to manufacturer contribute to the service difficulty.

Technicians cite reasons for service problems and challenges:

- "SMDs are hard to find and expensive. The equipment to fix them is expensive as well."
- "Some components are impossible to replace without expensive soldering stations."
- "Technology is out pacing the average repairman's ability to stay abreast."
- "It is easy to damage circuitry through handling."
- "We have mostly older technicians. Older technicians have poorer eyesight."
- "We are becoming board changers, not technicians."
- "Due to SMDs' size, delicacy and similarities of package, repair is physically more difficult."
- "More micro-sized parts are touchy to work with."

Some repairs require manufacturer intervention—sending radios back to the manufacturer—according to respondents. Statistics show that 58.1% report less than 10% of repairs are sent back to the manufacturer, with 25.8% indicating 10% to 25% of repairs require manufacturer assistance.

The cost of repair sometimes is more expensive than providing a user with a new unit, according to 51.6% of the respondents, while 41.9% disagree. Comments include:

- "A lot of radios are priced and service costs are priced such that they are becoming throw-away technology."

Radio design trends

- Multilayer boards
- SMD components
- Computer-programmed radios
- Micro-miniaturization
- 'Super chips'
- Non-generic parts
- More functions
- Closer pc components
- Data applications
- More plugs
- Modular design

- "A \$195 or less product's cost figure and shop rates approaching \$100 per hour do not compute."

• "In some cases it is cheaper to buy new equipment, and sometimes repair is as simple as a bad solder joint. I have found many repairs to be nothing more

than poor solder connections that should have been caught at the manufacturer's quality control department."

- "1% to 2% are uneconomical to repair. If replacement parts keep going up as units get cheaper, this percentage will increase."

• "Almost all repairs are cheaper than a new radio."

- "Most repairs are done under \$50 vs. \$150 to \$400 for a new radio."

A trend away from dealers servicing radios continues, according to 69.4% of the respondents. Readers outline some of the reasons for this trend:

- "Companies are designing equipment to require manufacturer involvement in repair."

• "It is cheaper than to stock all the special parts and tools."

- "The manufacturer has equipment for diagnostics."

• "Small dealers cannot keep up with the technology."

- "Modular design and bad service information—some manufacturers will not send service information."

• "Radios have no test points, poor manuals and integrated circuits do too many functions."

- "We cannot afford the new type of test equipment that is needed, and not too many technicians now know how to service the newer units."

Repair challenges

Technicians face difficult servicing

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challenges. These include:

- "Circuit boards piggy-back and smaller switch solder joints."
- "Disassembly to the point of locating the part to be replaced. Also, power on testing with the radio apart."
- "Finding the problem quickly to keep the repair cost reasonable."
- "Getting it to function normally when it is opened for service."
- "Finding test points and accessing them with proper probes and physically replacing defective parts."
- "Being able to service the unserviceable."
- "Physical access to the trouble area. Component replacement of flimsy circuit boards or mylar film."
- "Replacing components without causing heat damage. Accessing components in operating position. A radio spread on the bench operates differently than when it is assembled."
- "Tracing the problem down to a specific part in microprocessor-based radios."
- "The most difficult: Telling a customer a unit's repair is not worth it. Thus losing an income, rather than selling the job at all costs."
- "To replace components on multilayered boards and not damage the board, and access to troubleshoot—compact and sealed up."
- "Weird little intermittent things that cannot be isolated without spending several hours trying to catch them."

Design trends

Design trends technicians foresee that will cause servicing problems in the future include:

- "Boards that unplug from each other and require specialized, non-supplied jumpers."
- "Closer printed circuit boards—solder runs too close for repair."
- "Further miniaturization."
- "High-density packaging."
- "Lack of specialized data analyzers needed to troubleshoot central processing units (CPUs) in new products. Excessively complicated equipment as compared to older solid-state equipment which was reliable and simple."
- "Modifications not recorded on unit schematics."
- "Microprocessors and their ex-

posure to the hostile environment of a mobile, i.e. temperature extremes, vibration, vehicle electrical systems."

- "Computer-programmed radios."
- "Data applications."
- "Highly concentrated and populated circuit boards—multilevel boards ensure difficulty."
- "Micro-miniaturization."
- "More integration and microproc-

essors make more features and more problems."

- "More 'super chips' and more surface-mount technology. More use of non-generic parts."
- "Surface-mount and modular design."
- "More functions in smaller packages."

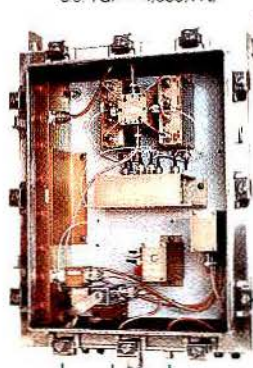


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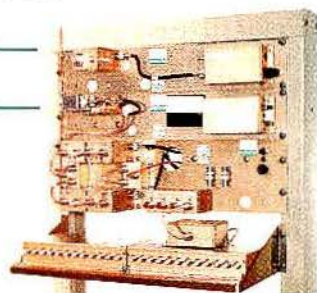
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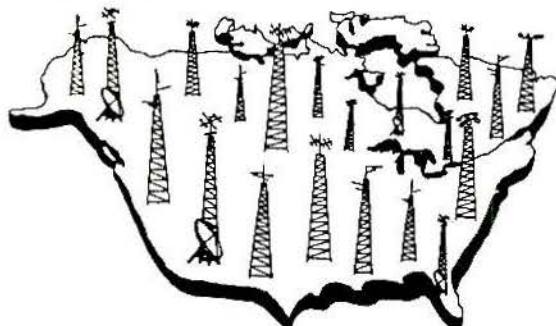
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Seciniaz

Dennis C. Connors advances from director of marketing to vice president of marketing for Ericsson GE Mobile Communications' Land Mobile Radio business, Lynchburg, VA.

Marlin R. Gillette leaves Calspan, a division of Irvin Industries, Buffalo, NY, as an engineer to join Sti-Co, Orchard Park, NY, as product development engineer.

Laurent Seciniaz joins Andrew, Orland Park, IL, as vice president of communications products sales.

Promotions at Avtec, Gilbert, SC:

Jim Brigman advances from software development manager to research and development manager.

Don Rash moves up from systems engineer to technical support manager.

Darryl Mast advances from manager of quality control to manager of manufacturing.

Gerard P. Dennehy, a consultant to the board of directors, Coded Communications, Carlsbad, CA, becomes vice chairman. Dennehy replaces **Robert L. Hillman**, who becomes director of new business.

Stephen Hawthorne leaves Telefind, Coral Gables, FL, as a sales representative to join Radio Call, Melville, NY, as director of messaging sales for alphanumeric paging.

Lester Cushman, founder of Cushcraft, Manchester, NH, died Nov. 12, 1991.

Walt Henry, co-founder of Henry Radio, Anaheim, CA, died Dec. 1, 1991.

Bill Vogel, president of CSC, Birmingham, AL, died Dec. 13, 1991.

March

9-10—AMTEX '92, the American Mobile Telecommunications Association's Marketing & Technology Conference and Exposition, Tampa, FL. Contact: 202-331-7773.

29-April 1—Energy Telecommunications and Electrical Association '92, Dallas Convention Center, Dallas. Contact: 214-235-0655.

April

12-15—North Central Regional Conference Associated Public-Safety Communications Officers Meeting, Pheasant Run Resort and Convention Center, St. Charles, IL. Contact: T.G. Mieux, 708-244-8640.

May

7-9—1992 Annual Mobile Communications Conference, Westin ANA Hotel and Resort, Washington, DC. Contact: National Association of Business and Educational Radio, 800-759-0300.

11-13—Vehicular Technology Conference, sponsored by IEEE Vehicular Technology Society, Hyatt Regency, Denver. Contact: John Tary, 303-452-6111, ext. 443.

13-15—Radiocomm Annual Convention, Montreal. Contact: Lisa La Prairie, 613-233-4888.

17-20—East Coast Regional Conference Associated Public-Safety Communications Officers Meeting, Lancaster Host Resort, Lancaster, PA. Contact: James Giannini, 215-631-6500.



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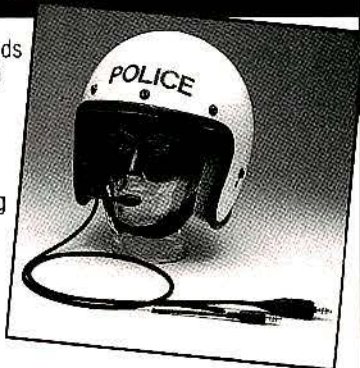
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Help wanted

Are you a experienced Two Way technician that likes to do something different every day? Well we have just the job for you. Must have at least five years experience on the bench or field work. Please send your resume to:

Two Way Radio Service, Inc.
418 North Conwell
Casper, WY 82601

Equipment for sale

USED PAGERS

Motorola and NEC. Reconditioned on your channel w/warranty, or "as is".

ACS (303) 337-4811
FAX (303) 337-3084

SWEPT SWR MEASUREMENTS The Easy Way!

Uses modern return loss bridge method. Highly directive: long cable runs no problem. Low cost: 5-1000MHz, 45 dB \$329.00. Interested??...See ad on page 69. Free application note: "Swept SWR Techniques". Call: (316) 942-5100 for catalog & ap note!

USED 2-WAY RADIOS Call Sid Cohen

at **AIR COMM—Phoenix, AZ**
(602) 275-4505 • Fax (602) 275-4555
30%-70% savings on Motorola, GE, EFJ mobiles, base stations, portables, pagers, repeaters—primarily solid state—all frequency bands. Also, accessory items: Motorola "Systems 90" control heads. **PL and paging reads**, channel elements. Cash quotations made for purchase of above equipment.

AIR COMM 4614 E. McDowell Rd.
Phoenix, AZ 85008

Help wanted

Trade Magazine Technical Editor

Expansion has created excellent opportunity for cellular/RF expert to work on top technical publication in cellular field. Will write articles on technical aspects of cellular business, edit materials from outside authors and manufacturers, and offer technical assistance and expertise to other publications within group. Must have understanding of mathematics and technical graphics sufficient to handle the cellular radio subject matter covered. Technical degree preferred. Send complete resume and salary requirements to: **Mobile Radio Technology**, P.O. Box 12901, Dept. 916, Overland Park, KS 66282. EOE M/F/H

Equipment for sale

WE BUY AND SELL USED MOTOROLA AND GE FM TWO-WAY RADIOS

- 1 MSF5000 RPTX, 900MHz, C65GFB7206AT
- 231 GE CORONA, 800MHz TRUNKED MOBILES
- 45 GE MARK V, 800MHz TRUNKED PORTABLES
- 27 MICOR, 800MHz CONVENTIONAL, T45RTA6000
- 2 MSF5000 RPTX, 460MHz, C74CXB7106BT (DVP)
- 2 MICOR RPTX, 460MHz, C64RXB3106AT (DVP)
- 1 MICOR COMM. RPTX, 460MHz, C64RCB3105T
- 12 SYNTOR, 460MHz, T74SRA3000
- 30 MICOR, 460MHz, T74RTA3000
- 12 MOSTAR, 460MHz, D44TZAD700
- 25 MT500, 460MHz, H34BBU3110
- 1 MICOR BASE, 173MHz, B93RCB3105
- 1 MICOR Base, 163MHz, C73RTB1105
- 10 MAXAR 80, 173MHz, D43TSA3000
- 30 MX350, 165MHz, H43AXU3120 (DVP)
- 1 MICOR BASE, 165MHz, C53RXB3126AC (DVP)
- 1 MICOR Base, 155MHz, C73RTB3145
- 5 CONSOLETTES BASES, 153MHz, L43BBB3000
- 28 MITREK, 153MHz, T63JUA3000
- 185 MICOR, 153MHz, T73RTN3100
- 22 MT500, 155MHz, H33BBB3184
- 1 MICOR PURC BASE, 72MHz, C72JZB6106

SCHAEFER RADIO CO.
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(319) 984-6115 or FAX (319) 984-6220

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National openings for experienced Cell Site Techs, Switch Tech, and other **TECHNICAL PERSONNEL** at all levels within Cellular Communications. Locations in a number of markets.

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COMMUNICATIONS RECRUITMENT SINCE 1957.

PAGER TECHNICIAN

Experience on Motorola and NEC needed. Salary commensurate with experience. Full benefits. Send resume and salary history to:

McManus Communications
400 North 5th Street
Blytheville, AR 72315
501-763-6250

Equipment for sale

REPEATERS FOR SALE

Mot. MSF5000, UHF, MINT!
110/85 Watts Cont. Duty.

➔ w/TONE REMOTE!
800-231-0103 \$4975.

STANDARD HX400

- 25 Channel VHF Portable
- Scan w/Priority, LCD
- Rapid Charger & Battery
- Programmed at NO CHARGE!
- Used - Good Condition

ONLY \$299!

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WHY SETTLE FOR ANYTHING LESS

New Motorola and NEC Pagers



BRAVO

One call can get it all...

- Competitive Prices
- Quantity Discounts
- Many Types Available



IDP5000

New Lower Prices on
NEC Pagers

Also available:

- Reconditioned Pagers
- Recrystal code plugs
- Refurb Kits
- Batteries
- Parts

WE BUY PAGERS

McManus Communications

400 N. 5th
Blytheville, AR 72315
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FAX: 501-763-6533

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...TO KEEP YOU
COMMUNICATING

**LIGHTNING/EMP and
GROUNDING SOLUTIONS...**

primus

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Circle (97) on Fast Fact Card

UNIDEN AMH300

Used-Like new condition
2 channel, Xtal controlled
VHF 148-174 MHz
Underdash mounting
Complete w/all accessories

\$125 ea.

VersaTel

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ABOUT WHAT LABEL COMPANY TO CHOOSE?

We are one of the oldest pager label companies recommended and used by the leading pager manufacturers in the country. We are a total custom label mfg. We make the label that you need to your specifications.

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Send for samples and a FREE sample of Clean-A-Page (label remover & cleaner).

Anchor Graphics

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MOBILES & PORTABLES 800 MHZ TRUNKED

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35 WATT MOSTAR 15 SYS/TEL ATM	\$495.00
35 WATT MAXTRAC 10 SYS B7	\$695.00
35 WATT SYNTOR x2-x3	\$250.00
35 WATT SYNTOR x 15 SYS/15 SUB/CONV	\$995.00
35 WATT PP1000 OR PP500x	\$995.00
2 WATT MTX800 W/CHARGER	\$645.00
2 WATT MTX810 6 SYS/3 SUB CHARGER	\$745.00
1 WATT STX 15 SYS W/ RAPID CHARGER	\$695.00
3 WATT STX 15 SYS W/ RAPID CHARGER	\$995.00

MOBILES & PORTABLES 900 MHZ TRUNKED

12W B2 MAXTRAC	\$595.00
12W & 30W B2-B5-B7 SPECTRA EROM	\$695.00
2W MTX900 B3 & B4 6 SYS/3 SUB EROM	\$795.00

CONVENTIONAL RADIOS

110 WATT MITREK VHF 4F PL	\$595.00
100 WATT MITREK UHF 4F DPL	\$595.00
30 WATT MITREK UHF 4F PL/DPL	\$245.00
35 WATT MITREK 800 MHZ 4F PL	\$275.00
30 WATT SPECTRA 800 MHZ B5	\$745.00
60 WATT MAXTRAC 2F 30-36 MHZ	\$425.00
4 WATT HT440 / 2 WATT MT500 /SW HT90	\$195.00
5 WATT HT600 VHF 6F RAPID CHARGER	\$445.00
25 WATT MAXTRAC 16F UHF SCAN	\$495.00
45 WATT MAXTRAC 2F VHF	\$445.00
75 WATT MSF5000 DUP MPTI TEST PAN	\$4,995.00

SPECIALS

15W MAXTRAC TRUNK 800 B7 10 SYSTEM	\$595.00
100W MICOR 4F PL UHF COMES WITH	
SUPER DUPEL ACCESSORIES	\$150.00
5W MX350 UHF 8F PL RAPID CHARGER	\$195.00
72 CHAN VHF SABER 11/DVP NEW IN BOX	\$995.00
120 CHAN UHF SABER111/DVP W/CHARGER	\$1,495.00
120 CHAN VHF SABER111 W/CHARGER	\$1,295.00
100W SYNTOR X UHF 16F MPT	\$995.00
DATA LOG W/UNIPAK 28 AS NEW	\$2,500.00

WE BUY STX-MTX-MAXTRAC-MITREK-MT1000-SABER
SYNTOR 9000-MOSTAR-MSR2000-MSF5000-SPECTRA
RADIO EXPRESS 703-266-1928 FAX 703-830-8710

Circle (99) on Fast Fact Card

ULTRA-COM 96



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- DYNAMIC PROGRAMMABILITY
- MICROPROCESSOR CONTROL
- MULTI-FORMAT PAGING
- MANAGEMENT REPORTS
- PERSONNEL VEHICLE STATUS
- G-STAR INTERFACE
- E-911 COMPATIBILITY

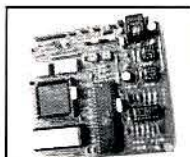
Desktop dispatch console
expands to 16 channels

**MODULAR COMMUNICATION
SYSTEMS**

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Circle (98) on Fast Fact Card

Natural Voice Playback



- Repeater Identifiers
- Site Alarms
- Remote Telemetry
- Weather Stations
- Multiple Languages
- Emergency Announcements

DataVoice - DV-64

Add a **Recorded Natural Voice** to your system or equipment. Voice vocabularies consisting of over 100 words or **multiple phrases** up to 1 minute in a **Natural Voice** is saved in Non-Volatile E-Prom memory. (If power is removed the recordings will not be lost). We'll record your message(s) in a male or female voice - or - you can record the library by using the optional SDS-1000 development board on an IBM or compatible computer.

Parallel input word select	8 ohm Audio output
500 ma keyline output	600 ohm Audio output
32 Kb sampling rate	+9v to +14v supply
Multiple modes	Size: 4.00" x 4.25"
Selectable timing	Connectors included

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MOTOROLA
RECONDITIONED RADIOS
HUNDREDS IN STOCK
800-231-0103
CALIFORNIA RADIO

Equipment for sale

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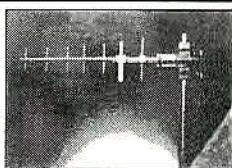
DECIBEL

►Quality Products

- DB 806, 806-960 MHz, 6dB gain
- DB 809, 806-960 MHz, 9dB gain
- DB 810, 806-960 MHz, 10dB gain



- DB 432, 450-470 MHz, 8dB gain
- DB 436, 406-512 MHz, 10dB gain



►Competitive Prices

►Shipped Same Day

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SITE MANAGER SYSTEM / BC100 SITE MONITOR

- 8 analog inputs • 8 digital inputs • 8 out
- User set-up to monitor 1 to 8 transmitters
- DTMF/FSK/RS-485
- Unused inputs may monitor temperature, AC, etc.
- Dial-Up phone • Radio • Wire pair
- Host software for PC or compatible/RS232 from host computer, Operator may:
 - Set Hi/Lo Analog Limits
 - EN/DIS any analog/digital in or entire unit
 - Turn on/off the 8 controlled outputs
 - Interrogate site
 - Assign plain language names & units
- Automatically reports alarms to host computer
- Easily expanded to 255 units max. Add capability when needed.



Berry Controls Inc.

23 N. Central Ave. • Canonsburg, PA 15317
(412) 746-8888 FAX (412) 746-9189

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LARGEST MOTOROLA GE INVENTORY CALL OR FAX FOR CATALOG

MOTOROLA UHF REPEATERS 75W...\$CALL.
Maxar 42-50 DSITSA4300 55W...165
Maxar 150-174 D43TSA1900 50W...150
Mocom 70 VHF 25W w/acc. 4ch...50
Mocom 70 VHF 25W range only...25
Delta-s 150-174 no. acc. 110W...275
Phoenix-SX UHF 16 ch w/acc...250
Phoenix-SX VHF 16 ch w/acc...235
MASTR II 150-174 110W from...115
MPI port. 4W eg 150-174 new...225
MPI port. 2W eg 150-174 new...195
MPI port. 2W eg 136-153 new...195
MPI port. 4W es 150-174 new...195
S-700 weather proof scan control
with all accessories new...225
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Some new...\$500 ea.

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79F1-02 1 HOP + Spare
\$2,000

WANTED

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FAX 818-308-3909

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□ PAGER CRYSTALS

□ COMMUNICATION CRYSTALS

□ CHANNEL ELEMENTS

- Recrystallized
- Compensated
- Complete Elements

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FAX: 1-606-283-0883

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(Greater Cincinnati Area)

"Precision Quality Quartz Crystals
Made to Your Specifications"

**48-HOUR
SERVICE
AVAILABLE**

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• MOBILES • BASES • PORTABLES • PAGERS • REMOTES •

PCI — PEKAAR COMMUNICATION INC.

Steve's back, formerly of Gregory Electronics Corp.

\$ Specials of the month. \$

GE Exec II RT64AAU33 60W, 42-50 range mobiles w/acc.	\$135
GE PY or PE 12V, vehicular charger only	\$20
GE MPR or MPX rack charger	\$65
GE Phoenix Mobile N3A01 HG, crystal type	\$125
GE SF1000 Telephone Handset	\$15
GE Mastr-Pro MP65AAU881, 450-470 range or 470-490 w/acc.	\$135
GE Mastr-Pro Base DM76TAU66, HB or LB	\$300
GE Delta TRS Boards 42-50 range, 19D901153G3	\$40
Mot. Mocom-10 450-470 range, L34AAB3100, front mt.	\$125
Kenwood PK8015 front mt.	\$140
GE MPR or MPX Batteries	\$5
Mot. Motrac Mobiles HB or LB, less acc.	\$25

Catalog Available

If you can't find it, try us!

Call (201)772-0704

• BOARDS • STRIPS • ACCESSORIES • ELEMENTS • REEDS •

Circle (102) on Fast Fact Card

New Device Forwards Calls to SMRs

Your SMR users can now be reached by the people who need to find them — without the hassle of over dialing.

New **LOGOS** provides selective call forwarding from a land line to any phone number — anywhere. The caller simply calls the SMR user's office number as usual and **LOGOS** will forward all incoming calls to the SMR, or

forward only those callers who know the VIP touchtone code. Compatible with SMRs, roaming cellular, private interconnects, paging and wireline systems, with or without over dial.

- Inexpensive. No monthly fee.
- Modular plug-in installation. All solid state.
- Requires only one phone line equipped with 5-way calling and DTMF signalling.

- User can reprogram **LOGOS** from any DTMF phone anywhere following simple voice prompts.

Call now for details:
1-800-442-4887

Made in U.S.A.



Logotronix Communications LLC, 12421 Washington St., Thornton, CO 80241

Dealer inquires invited.

Circle (103) on Fast Fact Card

Equipment for sale

COMPLETE CHANNEL ELEMENTS ON YOUR FREQUENCY FOR \$25 - \$35!!!

ORDERS ONLY:
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INQUIRIES AND IN LA:
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- ☐ Motrac; Micor, Mocom; Mitrek; Etc.
 - ☐ MT's, and GE Elements. Call for prices.
 - ☐ Any desired Frequency available for fast delivery.
 - ☐ Lifetime Warranty on Crystals
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 - ☐ We Buy Used Elements
- Try us first. We always have your frequency available.

NKX

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Gretna, LA 70053

GE 2-WAY RADIO WHOLESALE DISTRIBUTION CENTER

D&L CONNECTIONS

- Less than wholesale prices
- One million dollars of GE equipment
- Same day shipping • Express Repair power

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A DIVISION OF, D&L COMMUNICATIONS, INC.
3512 CAVALIER DRIVE • FORT WAYNE, IN 46808

Circle (104) on Fast Fact Card

Dual Control Head Adapter for EFJ Challenger Mobiles

Mark Bitting Inc.

P.O. Box 13; New Cumberland, PA 17070
(717) 774-7203

MARCH SUPER SPECIALS

3 MOTOROLA R3001C SER/MON \$3,995
MOBILES — W/ACCESSORIES

SYNTRON X UHF 100W 32 CHAN \$450
SYNTRON T44SRA UHF 50W 16 CHAN \$250
MITREK T44JJA UHF 50W 4 CHAN \$150
MITREK T43JJA VHF 50W 4 CHAN \$150
MITREK T74JJA UHF 100W 4 CHAN \$350
MITREK T71JJA 30-50MHz 100W 4 CHAN \$350
MICOR 100W Any Band 4 CHAN From \$150
MOCOM 70 42-50MHz 100W \$100
MOCOM 70 30-36MHz 50W \$75
MOSTAR UHF 40W 2 CHAN \$250
MAXAR UHF 15W-25W From \$100
PULSAR II VHF or UHF IMTS Bell Phones \$395
T1600 DC or Tone Remotes \$295
T1383AE Tone Remotes \$100
GE Deson & Secode DC Remotes \$50
MASTR II 75-100W Any Band \$200
MASTR II 45W UHF - Repeater Builders \$175
MASTR II E 42-50/VHF 100 W Repeater Builders N/A \$150
EX 11 UHF 75W 8 CHAN Repeater Builders N/A \$150
PHOENIX UHF SX 16 CHAN 25W \$250
GE MVP Mobile VHF 25W \$150
MITREK 800MHz 35W 5 CHAN DPL \$250
REGENCY U34 UHF 40W PL 4 Fr \$50
KENWOOD TK801S UHF 25W PL \$100
MOT MODEM 100 Encoder \$150

BASES — REPEATERS — PAGING TX

WE WANT TO BUY MORE RPTs & PAGING TX \$SCALL
MOT UHF & VHF, 30-50 250-500W TX From \$995
MICOR 250W Base Station From \$1495
MOT P44SYS Suitcase 12W UHF Repeaters \$1995
MOT MICOR Base/Repeaters Any Band From \$995
MITREK Base 50W Any Band From \$495
MITREK Base 100W Any Band From \$795
MOCOM 70 Base 50W Any Band From \$295
MOCOM 70 Base 100W Any Band From \$595
FLEXAR Base 800MHz DC/LOC DPL, \$200
Final Close Out, MASTR PRO BASE \$100 RPT \$150

Sold with accessories including Reeds & Crystals,
GUARANTEED WORKING

We buy/sell used Motorola & GE Mobiles & Bases — Trade Also.

We do not buy/sell pagers, no portables or parts.

BARNETT ELECTRONICS

FAX — 501/835-8766

8718 Wilshire Lane • N. Little Rock, AR 72120

(Orders & Bids Only) 800-423-3858

(Information) 501-835-7066



Bob Barnett

Circle (123) on Fast Fact Card

MECHEM ELECTRONICS

P. O. Box 7846

Fredericksburg, VA 22404

(703)373-3888

Portable and Related Equipment

GE PE Portables VHF
Portables II's 150-174 & 450-470
PE Charger 366L3A1X
Portamobile II Charger 375C1A2X
GE PE 30 Pocket Rack Charger
PT Pack sets 30-36 MC
P1025 PX Packsets 150-174
P1157 MX Nicad Charger Analyzer
Sleeve Chargers PT & PX Packsets
Pocket Surveillance Transmitters
MT, MX H1440 Single and Rack (STD or Rapid Chargers)

Mobiles and Accessories

Micor Cables, Heads, Speakers, Front/Rear Accessory Groups
Scan System 90, Sirens and More

Micor Receivers, Exciters; PA's; AF Squelch Boards Etc.
GE Delta Synthesized Mobiles LB & VHF
T64SRA3200BK 406-430 PL 8F Syntrons
Pulsar II and Novatel RCC Phones

Miscellaneous

VEGA Pro Wireless Mike Systems
Telex Wireless Mikes and Receivers
Marine Equipment by Motorola and Ray Jefferson
P1001 BX DVP Code Inserters
TCC807 and Lier Siegler Scramblers
URC101 Battery Boxes and Lithium Inserts
Phone Patches, Base Cards, CIU T1600's CALL
Centracom I Systems; Cards, P.S. Cables and Consoles
EMS Equipment; Memcom Apocors Complete and Parts
Spectra Tac, SQM's, Receiver Parts

Visit our shop at 1003A

Tyler Street in Fredericksburg.

Direct all correspondence to our P.O. Box.

Circle (105) on Fast Fact Card

Swersweep SWR Measurement Kit

Swersweep is designed to work with modern service monitors with tracking generator and spectrum analyzer enabling a plot of SWR vs. Frequency on the CRT display. Swersweep allows the instrument to function as a scalar network analyzer. See feature article on page 64 of October 1989 *Mobile Radio Technology* for more information.

Uses:

- Tuning Antennas: Base, mobile, or glass
 - Tuning cavities, duplexers, or filters
 - Tuning preamps and Receiver front ends
 - Checking transmission line and trimming to resonance
- Each Swersweep is hand built with calibration traceable to the National Bureau of Standards.

1-500-Mhz \$350, 1-1000 Mhz, \$675

Prices include shipping.

Europa Marketing

2358 S. Patterson Mesa, AZ 85202
Phone: 602-345-6666

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FAST DELIVERY

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Motorola/Radios Upgrades and Conversions

Upgrade your existing Conventional AND Trunked equipment with

Additional Modes,
Scan, Signalling Systems and
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32 Channel Mobile Upgrades from \$59.00
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RadMax Communications

COMPLETE COMMUNICATIONS SERVICE
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513-489-1732

ICOM Sales and Service 800-SPOT-CRIME

SWS Security

FOR SALE

KUSTOM ELECTRONICS INC. Mobile Data Base Station Equipment

- 1 NC-80 Communications Controller
- 2 Intelli-Koders (1200 baud)
- 1 Remote Base Station Controller

A \$35,000 value; call with offer:

Rusty Schwarz

914-365-7623

RADIUS P10

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40 YEARS OF QUALITY



INTERNATIONAL CRYSTAL MANUFACTURING CO., INC.

PAGER, PORTABLE REPAIR

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Equipment for sale

COOK'S COMMUNICATIONS

GE  **LTR**

160 N. Broadway
Fresno, CA 93701

VISA
MASTERCARD

**MOBILE AND PORTABLE RADIOS AT
WHOLESALE PRICES**

1-800-233-8818

GREAT MARCH DEALS AT C.W. WOLFE!

BASES/REPEATERS

MOT MICOR CS3RTS103
H.B. Local Control (like new)
1 MOT Micor C64 Retr. Cont. Duty
1 EXEC II, Lowband, 42-50MHz

MOBILES

40 GE Century II, 12.5 is
H.B. MVPs, clear, 3d acc
GE MASTR II UHF 40 watt all acc.
GE Delta S, VHF 40W 16ch, drawer only
MOT VT 500 VHF 45 WPL, as is
MASTR II, 40 watt
MOT PT 500 VHF CSD 4F & 8F
GE MASTR II UHF 100 watt 3UQ
1 UNICEN FTU-500K
1 UNICEN PMS-850T NO Acc, as is
2 MOTOROLA 447LA7000BK, UHF
50 MOTOROLA MICORS T74RTA3803BASP11
All Acc, as is
50 MICOR T54 RADIOS ONLY
50 MASTER EXEC II 132-155 Mhz, 45 watt

ACCESSORIES


MASTR II Acc Group \$80
MISCELLANEOUS \$300
Reg PE Charger \$25
GE PE 3 Hour Rapid Chargers \$55
Redicoda OTMF Mic's, MITREK \$20
MICOR SYNATOR Plugs \$10
25 MOT MC-70 Front Mt. control Heads \$50
12 HF 220 12 pocket wall charger \$45
Federa PA-20 Interceptor 100W Siren Amp \$45
2 MOT MR-96 Microwave Call for \$

WANTED


18 Delta S 40-50

SPECIALS

50 Standard Series 300 Portables w/charging
139 144MHz, as is \$75
2 MOTOROLA T-1600 Remotes \$300
2 TPL PA1-1AE 35.50MHz Power amps \$125
100 w/m
CALL FOR CURRENT FLYER

CW  **COMMUNICATIONS**

All sales cash or cashier's check. Fax: (406) 252-9617
1113 Central Ave. • Billings, MT 59102 406-252-9220



CALIFORNIA
RADIO

+

Radius®

YOU

=



A
GREAT
DEAL

Call now for the lowest prices and the best service in the U.S.A. We've been around for 19 years and KNOW how to please you!

GP300 Portables...IN STOCK
P100 Portables...IN STOCK
M100-M216 Mob...IN STOCK
P200 Portables...IN STOCK
Most accessories...IN STOCK
Service Manuals...IN STOCK
If we don't have it, we'll get it.

RECONDITIONED MOTOROLA RADIOS

HUNDREDS of Mitreks, Micors, Maxar 80s',
Moxys' and Super Consolette Bases IN STOCK.
All are Totally Reconditioned. Call with needs.

SPECIALS:

Expo Ports, MINT, 375.
Dazor arms & mike, \$79
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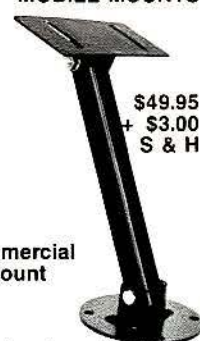
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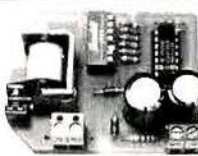
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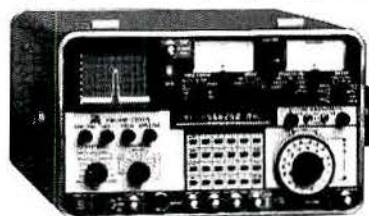
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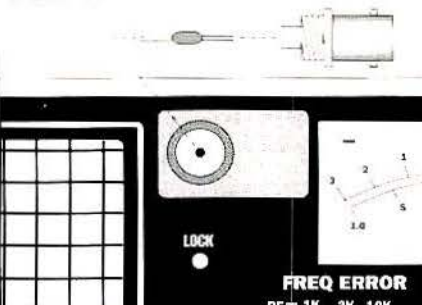


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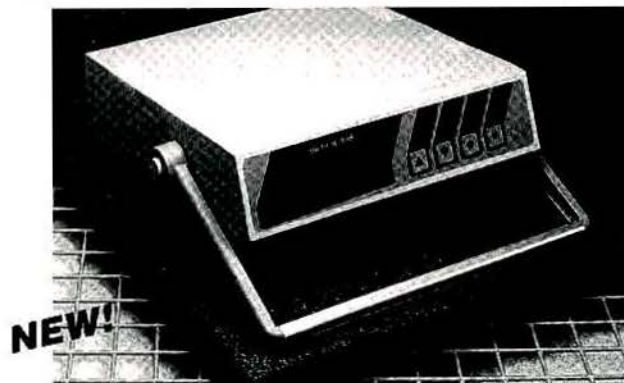
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